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Simulation For Commercial Driver License Third Party Tester Testing

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SIMULATION FOR COMMERCIAL DRIVER LICENSE THIRD PARTY TESTER TESTING

by

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for the degree of Doctor of Philosophy
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at the University of Central Florida
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ABSTRACT

The advance of technology is thought to help ease the myriad tasks that are usually involved in operating equipment. Training and testing in modern times have been replacing with simulation technologies that mimic the actual live operations and testing. Many successful stories of flight simulation come from military fighter aircraft and commercial pilot programs. The possibilities of safety in saving lives, economic incentive in reducing the operational cost and reducing the carbon footprint via simulation makes simulation worth looking into. These considerations quickly boosted the transfer from live training operations to virtual and simulation, as were easily adopted in the history of flight training and testing. Although, there has been a lack of application, the benefits of the computer based simulation as a modeling and simulation (M&S) tool can be applied to the commercial driver license (CDL) for the trucking industry. Nevertheless, this is an uphill battle to convince CDL administrators to integrate modern technology into the CDL program instead of using the traditional daily business of manual testing. This is because the cost of trucking industry live operations is still relatively affordable; individuals and companies are reluctant to adopt the use of the modeling and simulation driving or testing system. Fortunately, cost is not the only variable to consider for the training and testing administrators and their management. There is a need to expand the use of technology to support live operations. The safety of the student, trainer, and tester should be taken into account. The availability of training or testing scenarios is also an influencing factor. Ultimately, the most important factor is driving safety on the American road. The relationship of accidents with driver license fraud has led the Federal Department of Transportation to want to reduce fraud in third-party Commercial Driver License (CDL) administration. Although it is not

a perfect solution that can fix all, the utilization of simulation technologies for driving assessment could be a solution to help reduce fraud if it is applied correctly.

The Department of Transportation (DOT) authorized the states' independent authority to administrate the local CDL including the use of the Third-Party Tester (TPT). As a result, some criminal activities prompted the Federal investigation to recommend changes and to fund the states to take action to stay in compliance with the Federal regulation. This is the opportunity for the state CDL administrator to explore the use of M&S to support its mission. Recall, those arguments for the use of the M&S is the thought of safety in saving lives, economic incentive in reducing the operational cost, and reducing the carbon footprint via using simulation. This makes simulation a viable resource.

This paper will report the research study of using the computer based testing modeling and simulation tools to replace or augment the current state examiner as means of assessing the CDL TPT proficiency in basic backing skills. This pilot study of this system has several aspects to address. The scenarios must be relevant to test the knowledge of the TPT by using closely comparable scenarios to the current manual testing method. The scenario-based simulation should incorporate randomness to provide a greater sense of reality. In addition, the reconfigurable built-in random behavior scenarios provide the administrator greater control of behaviors and allow the administrator to be able to select among the random scenarios. Finally, the paper will present the data sampling from relevant participants of the CDL TPT and methodology applied. The analysis of data presents in this research study will be valuable for the State and Federal CDL administrator to consider the pros and cons of applying or adding a computer based simulation to their current testing methodology.

My dissertation dedicated first to my dear grand aunt, Vi Thi Truong, who I highly respected to call my grandmother. After World War II, when my grandfather disappeared, she ended up with the responsibility of raising my father and uncle. Just like the rest of my siblings, I grew up with her support and nurturing. My grandmother wanted to see each of us obtain a higher education. This is something that I have only been able to accomplish here in the United States of America. I thank the United States for the opportunity given to me to achieve this goal and my grandmother would be proud. It is also dedicated to my dear loving wife, Tamara, who I have known for most of my lifetime since I moved to the United States. She fully supports and is proud that I continue to strive for higher education given my challenging situation and disadvantage background. For the Truong family children, Austin, Eric, Katherine and Daniel, it is dedicate to having the younger generation be college bound. Sorry, daddy had to spend time to earn this achievement while you are at such a young age. Now, your dad will have more time to support you as you grow up and be ready for the challenges ahead.

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The effort of this scale would not be without support. I sincerely thank my committee members, Dr. Xu Yunjun, Dr. Bala Jaganathan, Dr. Lori Walters, Dr. Thomas Clarke, and particularly to major adviser, Dr. Kurt Lin for advising and advocate. Additionally, I also would like to thank Dr. Peter Kincaid (UCF M&S Program), Dr. Daniel Dwyer (NAWCTSD), Ms. Lisa Hernandez, Mr. Jimmy Sapp (Florida State Monitor), and the CDL instructors (at the Mid-Florida Institute, Key Power Driving School, Road Master Truck Training and, Orange County Bus Drivers). In each of their unique ways, they have helped me complete my dissertation. I know that without their help the processes would not have been smooth.

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LIST OF ACRONYMS/ABBREVIATIONS

AAMVA	American Association of Motor Vehicle Administrators
AAR	After Action Review
ASVAB	Armed Services Vocational Aptitude Battery
CAT	Computer Adaptive Testing
CCTV	Closed circuit television
CDL	Commercial Driver License
CFR	Code of Federal Regulation
CMV	commercial motor vehicle
CMVSA	Commercial Motor Vehicle Safety Act
CompTIA	Computer Technology Industry Association
CSTIMS	Commercial Skills Test Information Management System
DHSMV	Department of Highway Safety and Motor Vehicles
DOT	Department of Transportation
FAA	Federal Aviation Administration
FDHSMV	Florida Department of Highway Safety and Motor Vehicles
FHWA	Federal Highway Administration
FMCSA	Federal Motor Carrier Safety Administration
GVWR	gross vehicle weight rating
IDE	Integrated Development Environment
IRB	Institutional Review Board
IST	Institute for Simulation and Training
IT	Information Technology

M&S	Modeling and Simulation
MCP	Microsoft Certified Professional
MS	Microsoft
NAWCTSD	Naval Air Warfare Center Training Systems Division
OIG	Office of the Inspector General
PME	Probability of Missing an Error
RMM	randomized mathematical model
RNE	Random Number of Errors
TNSM	Total Number of Simulated Match
TOFT	Tactical Operation Flight Trainer
TPT	Third-Party Tester
UCF	University of Central Florida
VCRS	Virtual Check-Ride System
Virtual CDL TPT	Virtual Commercial Driver License Third-Party Tester
WWW	Word Wide Web

1. CHAPTER ONE: INTRODUCTION

1.1. Rationale

The advantage of science and technology continues to be its impact to change and improve human life. The implementation of science and technology products substitutes many dangerous and physical labor tasks that people used to do. Examples include automation, robotics, simulation, and other computer related applications. In training assessment, the revolution of using computers for testing systems such as Computer Adaptive Testing (CAT) has been utilized to certify practitioners in many professional fields such as Information Technology (IT), Microsoft Certified Professional (MCP), Computer Technology Industry Association (CompTIA) A+, Network +, and other certifications . Similar in application, CAT tests are also used to assess the education aptitude for college entrance and existing programs such as the ACT, SAT, LSAT, GRE, GMAT, etc. The same application is used by the military to qualify the recruit and officer candidate via Armed Services Vocational Aptitude Battery (ASVAB) and Officer Candidate Test. However, there are advantages and disadvantages in using computer technology to replace testing professionals in training or testing tasks. This leads scientists to continuously search for the optimal applied applications to utilize the computational models that these systems can provide. Fortunately, as technology advances and there is an increase in product variety, the potential applicable technology that also increase. As a result, scientists would be able to shape their concepts and testing of their ideas in order to find new and better solutions to augment or replace to the current process or systems. The process leads to the advent of better products for general use. While educators and administrators focus on training, testing is the crucial part of training equation. Just as important in the role of training and

developing, testing is parallel to training. Another way to view testing, that is training has been utilized as validation of the training. Utilize the modeling and simulation; the test developer can now take advantage of the science and technology to improve the test accuracy and making it more efficient.

Using modeling and simulation as an example, one of the best-known early simulation device is the Link Trainer, first available in 1929 (Link, 2010). The main purpose of the Link Trainer was to train the pilot in the use the flight instruments. Successors of the Link Trainer, such as the F-14 mission trainer and F-16 Unit Training Device, effectively train numerous flight skills. Such simulators are highly regarded as valuable assets to military organizations, just like operational equipment. Modeling and Simulation applications for training and testing are applicable in many areas that often taken for granted such as spacecraft, surface ships, submarines, land vehicles, nuclear propulsion trainers and many part-task trainers. In many instances, simulation is no longer optional, it is necessary. Modeling and Simulation is widespread and found to be effective and useful. To take advantage of modeling and simulation technology, it is just a matter of finding the application. The traditional Commercial Driver License (CDL) Third-Party Tester (TPT) qualification test is the candidate for the augmentation by using modeling and simulation for computer base testing.

1.2. Statement of the Problems

National growth in commerce and transportation requires goods and services to be transported from one point to another. This necessitates the use of semi-trucks to deliver these goods and services across the United States of America. In order to serve and protect the people and property from being harm by heavy commercial motor vehicles, transportation laws created to govern the interstate and highway system. As defined in Section 49, part 383 of the Code of

Federal Regulation (CFR), the Commercial Motor Vehicle Safety Act (CMVSA) of 1986. The law mandated the development of minimum standards for all commercial drivers nationwide. Therefore, drivers must acquire the Commercial Driver License (CDL) in order to operate a commercial motor vehicle (CMV). Interpreting this Act, the Federal Government mandated all persons who operate commercial motor vehicles to pass certain knowledge and skills tests. This major milestone was an aggressive change designed to improve safety and govern the nation's highways. This law changed the older regulation that enabled an individual possessing a driver's license for a four wheels motor vehicle to drive a tractor-trailer or a bus. Since the inception of the new rules, and in order to insure that the test meets the minimum knowledge and skills test set forth by the 49 CFR 383 for the safe operation CVM, the Federal Highway Administration (FHWA) has standardized the processes and requirements to issue CDL for CMV drivers. The State FHWA insures the state examiner, or monitor, plays a key role to insure the testing process correctly implementation. However, because of lack of the state examiner personnel, the CFR creates an exception to allow the use of third-party tester. According to the 49 CFR (2009) 383.75 third-party testing, which allows states to authorize a person (including another State government, an employer, a private training facility or other private institution, or a department, agency or instrumentality of local government) to administer the skills test as specified in the regulation if the conditions are met.

Thus, the implementation of the CMVSA of 1986 opened the door for the state of Florida to employ non-state employees or CDL TPT to share and serve as a role of the examiner. Official state government employee would normally hold the examiner position. Instead of testing the CDL drivers, the primary responsibility of the state employee or the state examiner shifted to insure the Third-Party Tester (TPT) is qualifying CDL drivers in accordance with the

standards mandated by the current legislation requirements. Additionally, Federal regulation mandates that the Florida Department of Transportation (FLDOT) must actively inspect the CDL TPT to insure that there is adequate training. In addition, the FLDOT must insure the assessment process for receiving the CDL is fair and accurate based on the merit guidelines for passing the CDL test. In response to that, the state of Florida must send the state employee as the CDL monitor or state examiner (usually a qualified examiner) to conduct site inspections and give guidance to the CDL TPT on the administration of the CDL testing.

Because the CDL monitor is required to certify the CDL TPT, the TPT certification traditionally accomplished during the time that a CDL student driver is taking the CDL test. This means that the state monitor will simultaneously score the student driver during the time that the TPT gives the test for the student driver. After the test, the state monitor will then compare the scoring with the TPT. The current or traditional CDL TPT qualification involved three actors the state monitor, the CDL TPT and the student driver. Planning for the qualification, the prerequisites of the TPT qualification include the presence of the state monitor, TPT and student driver, which can make the coordination difficult. During the testing event, the TPT focuses on testing and grading the student driver. While the CDL state monitor will focus on the performance of the test administration of the TPT by scoring and grading the student. Both parties use the identical scoring sheet form. The state monitor will rate and monitor the action of both the student and the CDL TPT. The traditional testing scenario depicted below in Figure 1.

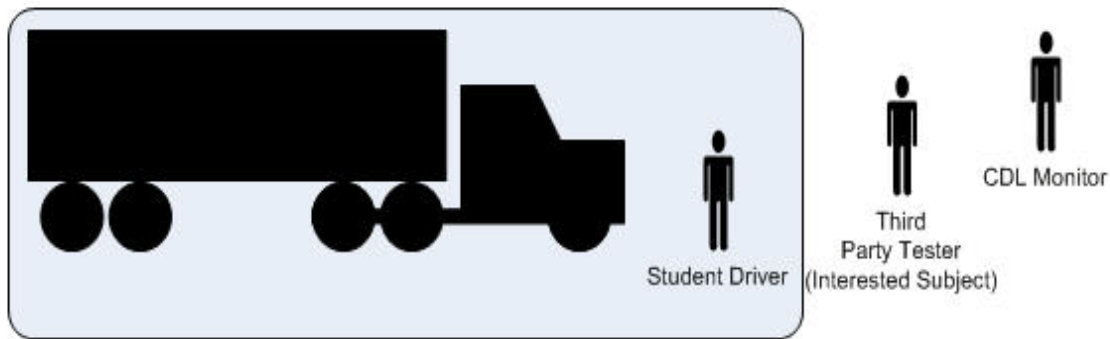


Figure 1. Traditional CDL TPT qualification test

The normal CDL test to be performed by the student driver includes:

- **General knowledge test:** a test required for the understanding of the driver manual.
- **Vehicle inspection test:** (sometime preferred to as a Pre-Trip) consists of testing the student's knowledge for determination if the vehicle is safe to drive.
- **Basic Control Skills:** exercises including all the subsets of the following tests:
Straight-Line Backing, Sight Side Parallel Park, Conventional Parallel Park, Offset Back—Right, Offset Back—Left, and Alley Dock as depicted in the set of figures below.

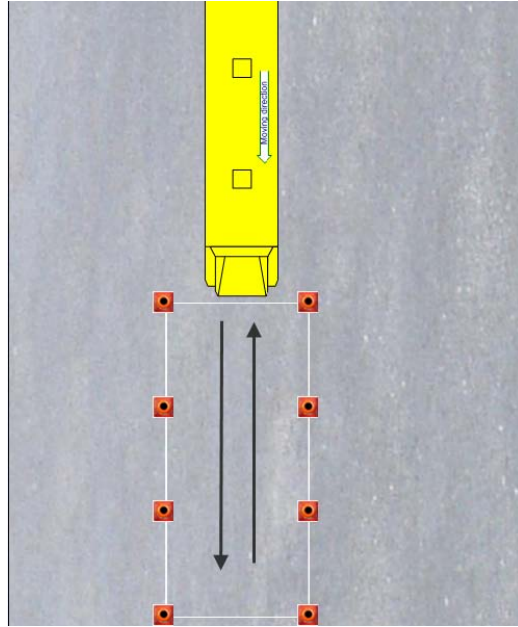


Figure 2. Straight-Line Backing

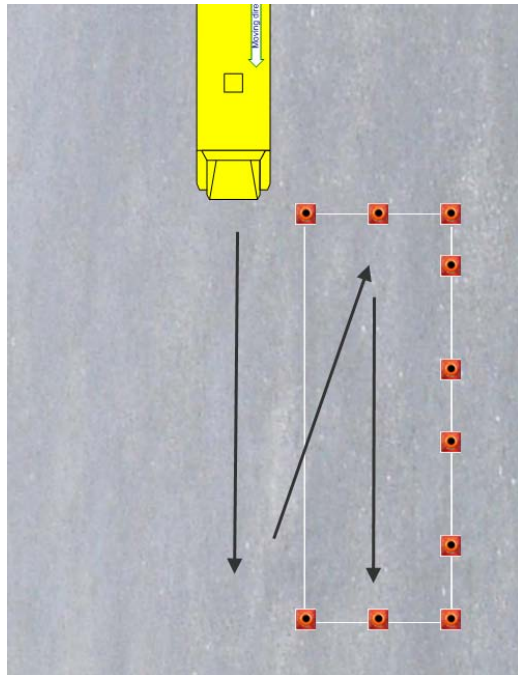


Figure 3. Sight Side Parallel Park

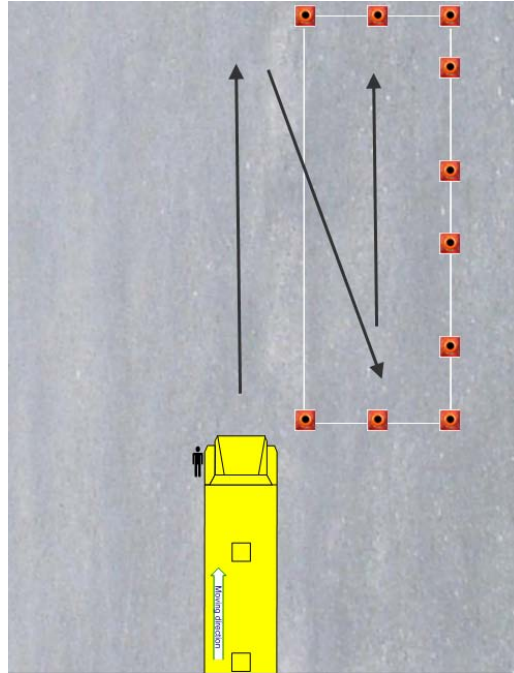


Figure 4. Conventional Parallel Park

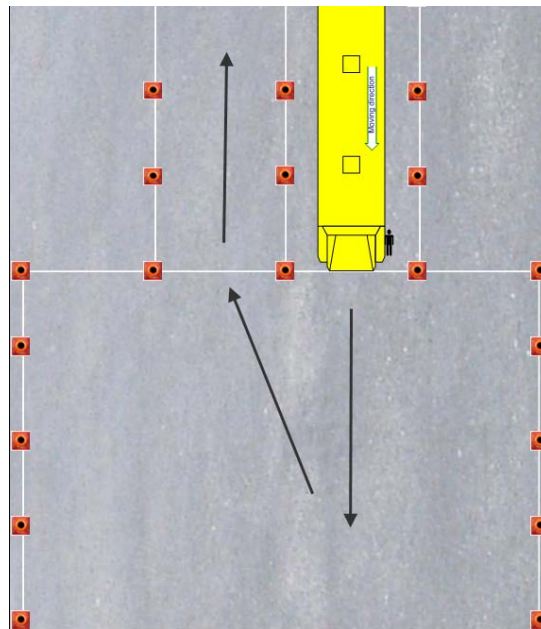


Figure 5. Offset Back—Right

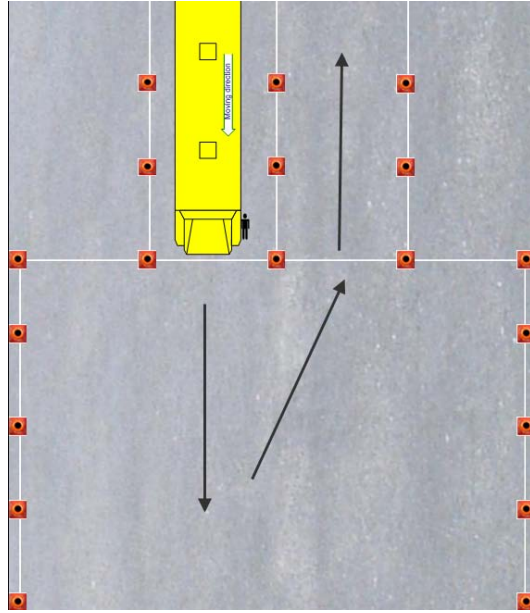


Figure 6. Offset Back—Left

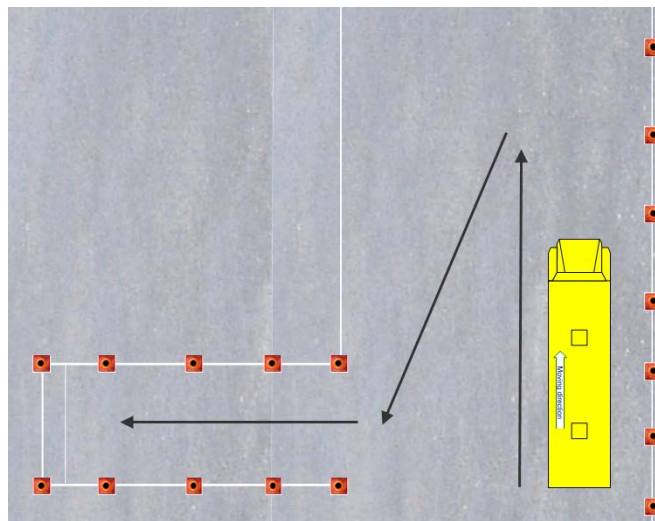


Figure 7. Alley Dock

- **Road test:** consists of testing to determine if the driver has the minimum level of skills to drive in most traffic situations

The area of focus for the CDL lies within the Pre-Trip inspection, Basic Control Skills and Road testing. The general knowledge is often not the focus of the CDL program since the

program requires a student to have a regular class E or passenger driver's license that qualified for the general knowledge test.

After the test, the two score sheets, one used by the TPT to test the student driver and the other sheet used by state monitor to score the same student driver will be used to compare scoring of the student for the TPT qualification. The intended purpose is to confirm if the driving test administrated by the TPT is fair, accurate and is being done procedurally to assess the skill and knowledge of the student driver. The state monitor will assess the TPT by reviewing the scoring range differences on the two score sheets. There is the allowable overall difference is plus or minus five (+/- 5) points. These differences are taking into account the three separate parts of the CDL test.

Observation the co-scoring processes, there are physical and procedural problems as limitations. Thus, next we are going to explore the process and observe the limitation of the current co-scoring process. During the first two parts, which are vehicle inspection and basic skills backing, the state monitor could easily co-score the student driver with the TPT. For vehicle inspection, the student performs the test by touching if possible or point out the part or systems under inspection. The student also verbally names the part and states the symptoms and signs that he/she is looking for. In this procedure both TPT and state monitor would be able to follow the student driver to walk around to witness the student inspects the vehicle. For the Basic Skill Backing, because of the physical limitation of the third-party testing environment, the test setup can be more difficult. Because of the minimum three (3) from six (6) randomly required, not all six course of driving maneuvers may be available to select at the training site. This often creates inconsistency among the test locations. The major problems in co-scoring occur in the road test module. During the road testing, the student driver must demonstrate

vehicle control on the road while being scored by the TPT. In many cases, road-testing co-scoring is almost impossible; this is because of the fact that most of the trucks being used during this test have only two (2) available seats. In the truck cabin, the student driver is using one seat, while the TPT is using the other. Therefore, it makes it difficult to have the state monitor conduct the co-scoring with the TPT during the traditional road test procedure.

The proposed solution, as shown in Figure 8, will be the process that uses state of the art computer technology to administrate the CDL TPT Basic Skills Backing qualification assessment. There are potential applications of the proposing process for the Pre-Trip inspection and Road-Test. This research study focuses on the Basic Skill Backings. Instead of the student driving a vehicle at the test location, using a computer software application, the student-driving scenario will be randomly selected and display on a computer screen to demonstrate the student is taking a test. The proposed process is to use the simulated animation video clip and software application to assess the CDL TPT basic skills backing efficiency. The qualified participant will take the test by watching the actions of the driving vehicle that is random selected by the random selection algorithm of the computer program. The participant will be able to grade the driving student using a score form that build in with the program. Since, the student driving scenarios are pre-scored. The test participant's grading action is equivalent to the traditional co-scoring process in action. The virtual test will keep track of the participant scoring record. At the end of the test, the computer program will list the total pre-scored and the given score by the test taker. The intended purpose for using pre-scored would be the substitute for the state monitor scoring task.

At the end of the assessment, the test application would be able to compile and display the scores. These are the scores which given by the test participant comparing to the score that

should be given based on the scenarios. The test application also keeps track of the scenarios presented and the set of the co-scoring scores. After the end of the assessment, the test application has an option for the test participant to review the student-driving scenario that presented. This review shows the description of the driving scenario in text. The review also guides with making up in the scenario where student driver was making mistakes and thus will help the participant to understand what the predefined score was based on.

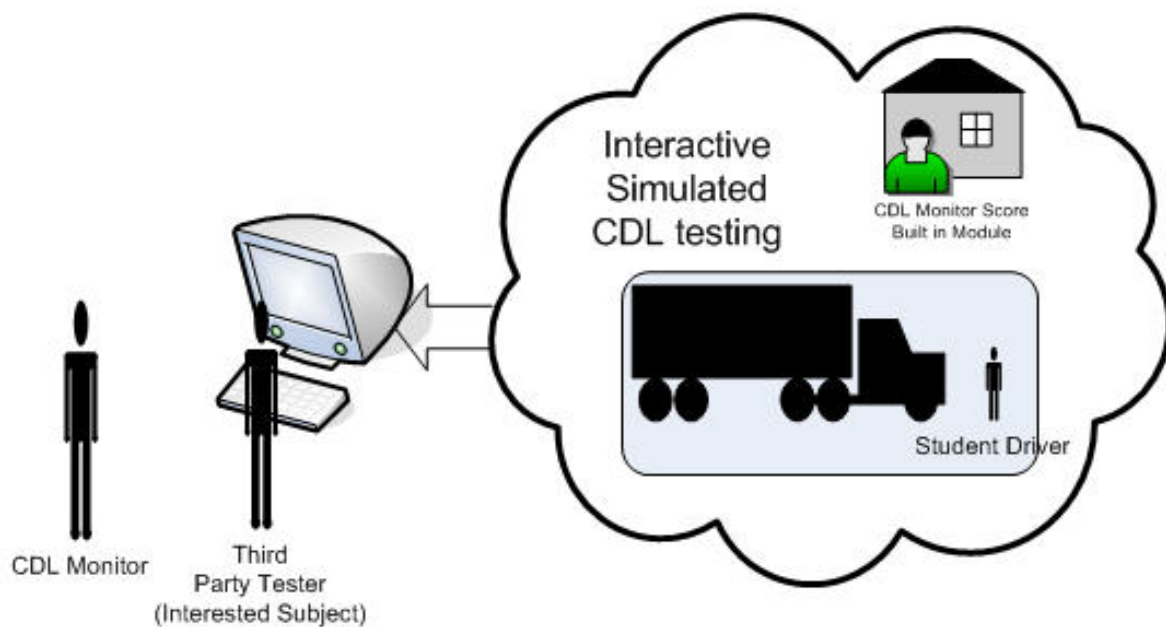


Figure 8. Proposed Virtual CDL Third-Party Tester testing system (Virtual CDL TPT) user concept

1.3. Research Questions

The hypothesis is based on the question listed below:

- Is the computer-based testing scenario software adequately assessing the Third-Party Tester knowledge in basic CDL backing up skills as it has been by the traditional method of using the operational equipment and student driver?

1.4. Purpose of Study

The main purpose of this research is to serve as the validation of the interjection and integration of the simulation testing utilizing computer-based technology to the current CDL TPT qualification testing process. The data results will be analyzed to study time savings and ease of administration. The results from data analysis will provide the economic incentive for the CDL administrator to adopt the recommended modeling and simulation processes. Additionally, the testing material developed for the Virtual CDL TPT test program is reconfigurable to serve the purpose of learning and practice for testing. To fulfill this purpose a series of studies to compare the amount of time taken to administer the test during the real life exercise versus the use of the simulated based computer assessment will be analyzed.

1.5. Research Significance

Nationwide CDL programs are acknowledging the lack of technology integration. While there are no perfect solutions, there are advances in the science and technology field of which CDL programs can benefit from. However, both the current practitioner's perceived low costs of operations in the traditional method and the lack of understanding of the knowledge to be gained for the industry workforce add to the resistance to change. Thus, the progress in adapting science and technology such as modeling and simulation in CDL program progress is very slow. In addition, even though some administrators perceive the advantage in using technology as a replacement or supplement to the traditional methods, these administrators still find difficulty in integrating new technology to replace the traditional methods. Lack of technology integration can spawn additional problems in CDL TPT implementation. For example, criminals are looking for the loophole in poorly integrated systems. Even in recent publications, there is not

enough direct evidence to place the blame on the CDL TPT as being at fault for fraud occurring in the CDL programs.

However, in the executive summary of the Association of Motor Vehicle Administrators (AAMVA) (2007), based on the United States Department of Transportation, Office of the Inspector General released a report in May 2002 stating that suspected criminal activity has been identified in at least 16 CDL programs jurisdictions. The AAMVA (2007) admitted that the issuance of fraudulent CDLs is a nationwide serious problem. To combat the CDL national problem, we would examine the current transportation laws.

At the Federal Government level, the DOT generates the code of federal regulation (CFR). Unfortunately, by design, the CFR is not meant to be too restrictive, as this would allow the local and States government to stay in compliance more easily. Thus, the consequence, the CFR compliance is reliant on the administration of the CDL programs by the state governments. Reacting to shocking report findings and searching for ways to correct or lessen the impact of the national transportation problems, the Federal Motor Carrier Safety Administration (FMCSA) (2000) released a series of recommendations for the States program to follow. Particularly for the State of Florida, there were thirteen recommendations in the area of CDL programs related to Organization, Operation, Testing and Training, and Information and Data System. These recommendations included:

- Adopting measures to equate safety performance with the existing customer satisfaction and service performance measures for Department of Highway Safety and Motor Vehicles (DHSMV) employees.
- Providing resources to significantly increase oversight of state-run and third-party test locations.

- Using statistical analyses of operational program activities, facility workload reports and program activity summaries for CDL program strategic planning and operational decision-making.
- Developing and implementing program management practices and procedures to regularly monitor the CDL testing program.
- Overseeing field operations, including facility audits and oversight of third-party programs and examiners.
- Establishing measures to control the use of interpreters in the administration of CDL knowledge and skills tests to insure complete impartiality of interpreters used in the process, and to validate that translator-assisted tests are equivalent to the validity of tests taken in English.
- Adopting the current version of the CDL knowledge test within one year of approval by AAMVA.
- Developing standards for the validation and verification of CDL applicant identity, including proper domicile.
- Assessing and explaining the wide disparity in monthly out-of-state driving conviction figures reported through the CDLIS.

The CDL TPT testing via computer methods would be the first of its kind. It is the beginning part of a series of the larger testing and certification for the test authority. It would provide a way to have better confidence in the training and testing tool for the state administrator. It would help insure that the professional testers are up to date with required knowledge to perform their duties. Although it may not be a solution to all recommendations for correction or solution to the recommended list above, the system would support some of the

objectives of the recommendation and thus will meet with the goal to enhance and improve the CDL program. Significantly, at the minimum by design and effort, the system will be straightforward, fair, offer time savings, easy to administer, and economical to operate as it is designed. Furthermore, the system would be another victory in implementation of the computer technology and science into our nation's transportation system and have an impact in improving the safety on the road for our nation's motorist.

1.6. Brief Overview of Methodology

To obtain the opinions of the participants before and after the experiments the researcher will utilize Pre and post questionnaires. Institutional Review Board (IRB) at the University of Central Florida (UCF) will review and approve the content for the questionnaires. Once accepted, the copies of approval letters will be included as the hand out material. A hard copy of Explanation of Research will presents to each participant.

The Virtual CDL TPT test program, based on using a set of simulated scenarios, will be developed to substitute for and augment to the current traditional co-scoring between the TPT and the state monitor. The selected participants are the TPTs and the state monitor. While presenting the randomized simulated driving scenarios, the testing program will keep the score to serve the role as the role of the state monitor. For additional features, the program will also keep track of the TPT grading score. The participants will take the test by grading the driving scenarios presented in the test program. At the end of the evaluation, the program will compile the given score and display the scoring differences, if any, between the correct responses versus the graded score. At the end of the test, the test participants will have the opportunity to review the test score. This process will reveal how participants scored during the test as how he/she

graded the student driver comparing to the system pre scored as by the correct score of the state monitor.

2. CHAPTER TWO: REVIEW OF LITERATURE

The goal of transportation is to bring individuals and products from point to point, according to the Federal Motor Carrier Safety Administration (FMCSA), and trucking is a way to transport goods and products all over the continent (FMCSA, 2006). The transportation process must be safe, cost efficient and achieve its goal. There are several modes of transportation such as air, shipping, train, numerous modes of ground transport. Because of the limited scope of discussion, only the land-based transportation mode related to the Commercial Driving Program including tractor-trailers and passenger buses will be discussed in this paper. Managing these processes is the highway safety defined by the United States Department of Transportation (U.S. DOT) by using rules laid out in the Code of Federal Regulation (CFR) to govern the implementation of the program. The ultimate goal is to protect the life of all people either on the road or off the road that could be affected by moving vehicles as the mode of transportation. The CFR mandates each of the state DOTs to establish a program that fits their local state requirements for transportation as long as it is at least as stringent as the original CFR. In the state DOT program, such as the state of Florida, it defines the criteria that the operator must meet in order achieve the state license to operate a vehicle within the state. Each state varies in how stringent the state DOT implementation and interpretation is when compared to the original CFR, in this case such a program that is compliant in one state may not comply with other states. However, they all meet the CFR stringent objectives. To operate a vehicle in Florida, the user is required to have passed a standardized test and obtained a driver license. Unlike the passenger vehicle operator license, the Commercial Driver License (CDL) in Florida heavily involves the use of a TPT. The TPT is the one who would train the individual operator and then administrate a test for the trainee. According to the Florida driving law, students have

an option to select the Florida State Examiner, the state employee, or the TPT to take the test CDL test. According to the state examiners, there are only six locations in the state that a student driver can take the test with a state examiner. Constrained by the availability of state examiner and facilities, the trainee would be better to select the TPT to take the test. This benefits the state since the TPT provides a better way to employ commercial businesses to add resources of test administration into the state run CDL program. Permitted and licensed by the Florida statute to manage the CDL test, the Florida CDL TPTs are all non-state government employees. Upon receiving their certification, license, and contract with the state, the TPT promises to administer the test and exams as outlined in the contract. However, because of the business investment nature and human interaction, the AAMVA (FMCSA, 2000) reported suspicion of fraud and abuse in the CDL program as a nationwide problem. The US DOT based in Illinois investigated and found there are hundreds of CDL licenses issued in some states found to be fraudulent and Florida was named as one of those states that issued these fraudulent CDL licenses (FMCSA, 2000). According to the CDL final report of 2002 (FMCSA, 2002), there is enough evidence to support that unlawful activities and unfair advantages are occurring within the CDL third-party program. This fraud has obvious consequences. Student driver trainees allowed passing the test with unqualified skills and abilities even when these student drivers have performed far below the approved standard. As a result, these drivers put other American motorists, property, and related environments at risk.

Analyzing the causes and looking for the way to fix the CDL TPT is something that must happen. However, it would be unfair to blame all the accidents that happen on the United States Highway as being caused by the CDL TPT derivative. Road accidents involve many factors and cause the need for the CFR to regulate the interstate and highway safety programs. The literature

review will explore various aspects of the transportation problems that lead to searching for a better solution in the employment of computer and simulation technology into the CDL testing program. Although there are some perceived advantages in using simulators in operational training and testing, there are also some disadvantages needed to discuss. The adverse effect of using flight or driving simulator such as simulator sickness should better inform as information provided to the administrator. Focus on relevant information, the literature includes the review of the recent US DOT accident reports, the federal and state standard, the state of Florida CDL program, the DOT CDL research in combating fraud in the system, the computer testing methods, and driving simulation availability.

2.1. Review of the Recent US DOT Accident Reports

Based on the 2006 US DOT accident report, large trucks, which by definition weigh over 10,000 pounds gross vehicle weight rating (GVWR) accounted for 7% of all vehicle miles traveled and 3% of all registered vehicles in the United States. The detail of the accident reports listed that 39% of the fatal crashes reported involving large truck drivers were caused by driving too fast, failure to keep in the proper lane, inattention, and failure to yield the right of way. The large tractor-trailer trucks pulling semi-trailers accounted for 63% of the large trucks involved in the fatal crashes and 47% of the large trucks involved in non-fatal crashes. In terms of the damage the large trucks involved in accidents have caused according to the 2006 report cited that out of the 42,642 people killed in motor vehicle crashes in 2006 that 12% or approximately 5,000 died in the crashes that involved large trucks. On the other side, injuries that occurred involving a large truck involved 106,000 people: 16% of those were killed and 22% of those involved were the occupants of the large trucks. Fortunately, according to the FMCSA U.S. DOT (2006) the trend of the accidents involving large trucks went down in comparison to the 2005 U.S. DOT

accident report. Which cited that approximately 5,240 people died in crashes involving a large truck and there were 114,000 people injured in crashes involving large trucks: 15% of those killed and 24% were the occupants of large trucks.

Because of the size and mass differential, more than 85 percent of the time, the fatality was not an occupant of the truck (NHTSA, 2005), (OMB, 2007). Thus, based on the number in 2005 and 2006 report, there are 76% and 78% respectively of the crashes involving large trucks that more than likely killed or injured occupants of passenger vehicles, buses, highway workers, bystanders, or others that were not an occupant of the truck.

2.2. U. S Department of Transportation (DOT) Federal and State Standard

COMMERCIAL MOTOR VEHICLE SAFETY ACT OF 1986

According to the Federal Motor Carrier Safety Administration (FMCSA), The Commercial Motor Vehicle Safety Act of 1986 was signed into law on October 27, 1986. The goal of the Act was to improve highway safety by ensuring that drivers of large trucks and buses are qualified to operate those vehicles and to remove unsafe and unqualified drivers from the highways. The Act retained the state's right to issue a CDL driver's license, and established minimum national standards, which the states must meet when licensing Commercial Motor Vehicle (CMV) drivers.

According to the Act, the Federal standard requires states to issue a CDL to drivers according to the following license classifications:

- Class A -- Any combination of vehicles with a GVWR of 26,001 pounds or more provided the GVWR of the vehicle(s) being towed is in excess of 10,000 pounds.
- Class B -- Any single vehicle with a GVWR of 26,001 or more pounds, or any such vehicle towing a vehicle not in excess of 10,000 pounds GVWR.

- Class C -- Any single vehicle, or combination of vehicles, that does not meet the definition of Class A or Class B, but is either designed to transport 16 or more passengers, including the driver, or is placarded for hazardous materials.
- Beside the classification, drivers who operate special types of CMVs also need to pass additional tests to obtain any of the following endorsements on their CDL:
- T - Double/Triple Trailers (Knowledge test only)
- P - Passenger (Knowledge and Skills Tests)
- N - Tank Vehicle (Knowledge Test only)
- H - Hazardous Materials (Knowledge Test only)
- X - Combination of Tank Vehicle and Hazardous Materials

If a driver either fails the air brake component of the general knowledge test or performs the skills test in a vehicle not equipped with air brakes, the driver is issued an air brake restriction, restricting the driver from operating a CMV equipped with air brakes.

The states are required to develop their own knowledge & skills tests, which must be at least as stringent as the federal standards with some exceptions such as those listed below.

- The general knowledge test must contain at least 30 questions.
- To pass the knowledge tests (general and endorsement); applicants must correctly answer at least 80 percent of the questions.
- To pass the skills test, applicants must successfully perform all the required skills (listed in 49 CFR 383.113). The skills test must be taken in a vehicle representative of the type of vehicle that the applicant operates or expects to operate.

- To administrate the third-party skills testing: federal standard required, other states, employers, training facilities, governmental departments and agencies, and private institutions can serve as third-party skills testers for the state.
- Tests must be the same as those given by the state.
- Examiners must meet the same qualifications as state examiners.
- States must conduct an on-site inspection at least once a year.
- At least annually, state employees must evaluate the programs by taking third-party tests as if they were test applicants, or by testing a sample of drivers tested by the third-party and then comparing pass/fail rates.
- The state's agreement with the third-party skills tester must allow the federal and the State government authority to conduct random examinations, inspections, and audits without prior notice.

Through the rigorous administrating and mandate requirements from the top level of the federal regulation standard, the administrating of the test is the states' business. state-to-state execution implementation is varies widely. This variation thus causes confusion to citizens. Depending on the states' interpretation and execution, not all driving testing programs administered in each of the states are equal. Since the investigation started in September 1998, according to the Evaluating CDL Program Vulnerabilities final report in 2000, Federal investigators from the Chicago Office of the U.S. Department of Transportation (DOT), Office of the Inspector General (OIG) was sent out to investigate in response to the alleged fraud in the administration of the Illinois commercial driver's license (CDL) program. As the investigation unfolded, problems were uncovered in the third-party CDL test administrators in the state of Florida (FMCSA, 2000). This involved the applicants traveling to Florida from Illinois to

fraudulently obtain the CDLs that they then brought back to Illinois to exchange for an otherwise valid CDL.

2.3. State of Florida CDL Program

In accordance to the state of Florida (FDHSMV 2008), all applicants for the CDL are required to have an Operator License and pass the vision requirements. Applicants must be at least 18 years of age. Operators under age 21 will be limited for intrastate operations only. While advising the test taker to study the State of Florida driving hand book, the state of Florida allows the oral examination to be given in English, Spanish or Haitian Creole. The use of the interpreters is not allowed in any part of the oral or CDL skill examination. The state of Florida CDL program consists of two basic kinds of the CDL examination: knowledge and skill tests. The knowledge test uses to assess the applicants' knowledge about vehicle safety and insure that it is sufficient. The skill tests consist of basic driving skills and the road test. Each type of tests are divided into three (3) different classes of vehicle specification and the operator is required to pass each of the tests depending on the selected class.

Table 1, CDL examination matrix

	Class A (trucks or truck combinations weighing 26,001 lbs or more, and towing a vehicle/unit over 10,000 lbs)	Class B (straight trucks and buses 26,001 lbs or more)	Class C (vehicles transporting placarded amounts of hazardous materials, or vehicles designed to transport more than 15 persons including the driver with a Gross Vehicle Weight Rating of less than 26,001 lbs,)
General Knowledge test	Yes	Yes	Yes
Combinations vehicle test	Yes	NA	NA
Air Brakes	Yes	Yes if applicable	Yes If applicable
Pre-Trip	Yes	Yes	NA
Applicable exams for desired endorsements	Yes	Yes	Yes
CDL Road Test	NA	NA	Yes

To study the General Knowledge test materials, one can find the information in the Florida CDL Handbook. Difference than the CDL classification, the special endorsements which allows driver to drive special type of vehicle. According to the Federal Law, it is required that the knowledge tests be passed depending on the special endorsements selected, the CDL Student Trainee is required to take one or more of the tests based on the requirement for each endorsement. The endorsement according to the FDHSMV is a special authorization, which permits a driver to drive certain types of vehicles or to transport certain types of property or a certain number of passengers. The type of the endorsements appears on the class A, B, or C CDL such as, Placarded Hazmat (H), Tank Vehicle (N), Passenger (P), School Bus (S), Double/ Triple Trailers (T) and Placarded Hazmat & Tank Vehicles (X).

From the federal regulation mandate, although, the CDL issued via the FDHSMV, the State can enlist the TPT to train and test the student operator by using a TPT. Thus, the student trainee can obtain the training courses from the TPT and subsequently take and pass the exam

given by the TPT or select the option to take the exam at the State testing facility from a state examiner.

2.4. DOT Combating CDL Third-Party Fraud

Per federal regulation standard, the administration of the CDL test is the state's business. Unfortunately, in the implementation, state to state CDL program execution are not the practically the same. In another words, depending on the state's interpretation and execution, not all driving testing programs administered by each state is equal. Addition to the confusing, the state level CDL program depends on the local interpretation of the law. Good or bad, some people would defend this practice, as it would be better for the local population to enforce their transportation governing law. However, this uncoordinated in the CDL program can cause confusion to the citizen, in particular the Federal Highway System does not discriminate the driver as different because the driver is from a particular state. At the beginning of the investigation in September 1998 according to the Evaluating CDL Program Vulnerabilities Final Report in 2000, federal investigators from the Chicago Office of the US DOT, Office of the Inspector General (OIG) was out to investigate in response to alleged fraud in the administration of the Illinois CDL program. As the investigation unfolded, problems were uncovered in the third-party CDL test administrators in the state of Florida, Georgia, Illinois and North Carolina (FMCSA, 2000). This involved the applicants traveling to Florida from Illinois to obtain the CDLs fraudulently. After that, they brought back the CDL they obtained to Illinois to exchange for a valid CDL from Illinois. With this process, the alleged applicants avoided the stricter CDL law and license processes.

Triggered by the fraud investigation, the U.S. DOT FMCSA came up with a formula to combat fraud in the area of commercial driver license (CDL) third-party examiner. As part of

the solution, the federal agency sponsored a project to use computer technology. According to the study conducted by the American Association of Motor Vehicle Administrators (AAMVA) for the FMCSA contract, the purpose was to develop specifications and pilot tests and an antifraud system for the commercial driver license (CDL) third-party testing activities. The project divided into two phases. Phase I includes three (3) tasks, for business requirement definition, technology baseline assessment, and specifications development and design. Deliverables for Phase I included documenting the business and technical requirements for a CDL antifraud system, detailing the current level of automation in jurisdiction licensing systems, and developing functional and performance specifications and a detailed design for a prototype and pilot system. The prototype system named the Commercial Skills Test Information Management System (CSTIMS). Phase II included two (2) tasks, for prototype, pilot testing and evaluation, and the task of final evaluation. Phase II delivered the prototype system, performed system testing, and is assessing the ability of the prototype system for combating fraud in the CDL program. The second phase also included the analysis estimated on the safety and security benefit offered by the CSTIMS.

According to the report, the differences between various jurisdictions taken into account; however, because by the design the CSTIMS meant to run over the Internet via the Word Wide Web (WWW) the different jurisdictions do not have to intervene to support the computer program. Only authorized users may have log-on accounts and access to CSTIMS from the Web site. The system process only allows the examiner (state officer) or tester (third-party tester) to schedule and administrate tests including the input of data from applicants into the system. A clerk will be required to verify the data before sending information to the jurisdiction administrator for insurance of the CDL.

The report reveals a series of large-scale pilot testing when the system was administrated in Alaska, Arizona, New Mexico, and South Dakota. Participants varied by each state, there was a total of forty-one (41) agencies and organizations that includes 117 examiners. The pilot test collected many helpful improvement suggestions and recommendations by the users including the reaction from the system usefulness. Unfortunately, the pilot test offers no conclusion. Thus, it leads to uncertainty if the system will meet the state's fraud detection/prevention goals. However, personnel from the state of Arizona admitted that the system would be a helpful tool. The additional benefit that such a system could bring to the CDL program is for record keeping. On the other hand, negative feedback also obtained from other users that the system should be more user-friendly. Particularly in CDL industry, system developers should pay attention that some users are lack of knowledge about computer. The use of a computer system may be intimidating to some. It has suggested having users buying into the system as a preliminary step before implementation.

2.5. Using Technology to Combat CDL Fraud

Technology in modern society promises to solve complex problems and assist human beings in achieving better security, training, and living a better life. This generation is fortunate to have myriad technologies available to combat fraud now compared to the past. Technology such as closed circuit television (CCTV) has been one of the tools used to provide better security and combat fraud. According to Wesh (2002), the camera recorder such as CCTV when visible would deter the potential offenders, who perceive an elevated risk of apprehension. The perpetrators would be detected and possibly removed or deterred when caught in the act. CCTV could be used to better and accurately point out to authorities to describe ambiguous situations if it is effectively installed and configured. It could accurately record the time that the fraud was

committed. CCTV would accurately present the occurrence of the incident of the alleged fraud better than human memory can record and recall. When the case is published over the Internet or through television media, the effectiveness of deterring this type of fraud is magnified. The studies, according to Wesh (2002), found that CCTV could be effective in reducing crime in car parks. The study recommended better lighting for effective and clear pictures and having the right camera setting are all-important aspects to collecting the data and deterring the potential crime. Thus, the video-camera selection is also an important aspect of the selection process to acquire the right equipment. According to West's report (2002), there is a selection of forty-six (46) cameras selected for the research study. The study found there are only twenty-two (22) cameras that passed the evaluation from this selection of cameras. In this case, statistically, there are less than fifty percent of the selected cameras meet the specification criteria for its use.

In simulation, simulators intensively use the CCTV to record the student's or the operator's action and then keep the video media for the After Action Review (ARR). The implementation of ARR for each simulator varies because of design and technology integration for each unique system. Because of common implementation, ARR found as an effective way to review. The recorded media reveals the operator or the trainee how they did during the training session. Thus, during the feedback session, the ARR helps the instructor with the recorded evidence for reference to point out area(s) where the trainee needs improvement or how the execution performed for the given tasks.

The negative aspect of using CCTV is that the usage can sometimes perceives as an invasion of personal privacy. Thus, sensitivity must take into account. Other consideration, the implementation of using CCTV must consider the acceptable application of CCTV under the guidance of the applicable laws that permit its use.

2.6. Simulation Testing with Computer Assisted Technology

2.6.1. Training and testing with the simulator

Training has evolved from traditional training methods (without any use of simulation or simulators) to modern training that takes advantage of the technology currently available for training. In driver operation training, according to De Winter (2008), the traditional form of training, being on the road with an operational vehicle is expensive, and research has shown that it does not reduce post license crash risk as compared to informal training such as using a driving simulator. (De Winter 2008). De Winter praised the fact that driving simulators being used as a complementary tool to on-road training offers certain advantages such as objective student assessment, standardization, free control over the training conditions, potential cost-effectiveness because of automation, and didactic possibilities such as multimodal feedback, demonstrations, and replay. (De Winter 2008).

Simulators designed to meet specific requirements for what they design to simulate. While the same group of simulator, which serves the same flat-form, has many similarity. However, each type of simulator is unique and different in many aspects including the physical hardware, the functional performance parameters and the software that drives that simulation. Despite these differences, operator training simulators such as the truck driving simulators, have many similar concepts like the flight simulator. There are numerous high fidelity truck driving simulators that were developed; however, the number of these simulators does not compare to the larger number of flight simulators. It would be difficult to determine whether developing a driving simulator with high fidelity would be more complex or costly than developing a flight simulator with high fidelity or vice versa. Even with a lack of detailed analysis, one can infer based on the complexity of the flight in motion through three-dimensional spaces and the

potential fatality that can happen because of pilot errors, it is easy to acknowledge that the flight simulator is more sophisticated than the driving simulator. Thus, one could also infer if part of the learning task to learn how to fly an airplane would be accomplished via a flight simulator; then, the part of the learning task to learn to drive could also be accomplished by using truck-driving simulators. This point is more of an illustration to the importance of simulators. It is not the comparison that the flight simulator is better than the driving simulator. The task and function for each type of simulator is for each own mission.

For flight simulator application, according to the Federal Aviation Administration (FAA), for many years, the flight crew training regulations in 14 CFR part 121 subparts N and O allowed simulator training as an enhancement to training and testing in the aircraft, but not as a complete replacement for training in the aircraft (FAA, 2006). However, that changed because of the improvement in flight simulator performance. As listed in the Appendix H of the regulation, FAA permits simulators used for varying amounts (up to 100%) of the training, testing and checking required by the FAA (FAA, 2006). However, the amount of training, testing and checking allowed based on the simulator performance has been assessed and commissioned by the FAA. According to the regulation, as the larger aviation community became interested in using the simulators, the administration intended to maximize the use of the simulator as long as the simulator meets the technical requirements outlined by the FAA. Since, not all simulators models created equal, the FAA continues to revise and improve the guidance for simulator technical capability. In recent years, the FAA certified the commercial pilot using the flight simulators. Known for the rigorous safety practice, the FAA acknowledged the benefit of the simulator. Because of the advancement of the simulator technology, FAA permitted the flight crewmember to utilize limited number of aircraft simulators for training, testing and certification

for the career field requirement. Additionally, the FAA recognized that using flight simulators rather than aircraft in training allows for more deep training, including the critical emergency procedures, in a safer environment. Not only do simulators provide improvements in safety and safer training operations, they also provide such benefits as reducing noise, air pollution and air traffic congestion, and conserving petroleum resources (FAA, 2006). In justification for the CFR, the FAA admitted it is necessary to promote the standardization and accountability for the flight simulator maintenance, qualification and evaluation for use in an FAA approved flight-training program (FAA 2006).

2.6.2. Other testing with the computer

According to Wilson (2005) in a letter to the editor of *the Chronicle of Higher Education*, the Graduate Management Admission Test successfully transferred to use the computer adaptive format back in 1997. After that, less than one (1) percent of the tests are giving by the paper test. In the recent announcement of the Medical College Admission Test are the Computer Adaptive Test (CAT) by 2006 is appraisable.

In an interesting implementation of the computer base testing report by Goldhirsh (1995), computer testing is being used instead of the routine drug testing to determine the employee stress level that leads to the safety mishap at work. From the surface, the computer tests are not connecting to the cause such as drug abuse. The drug abuse testing is often not accurate, costly and has been criticized as invasive to personal privacy. A PC based program called Factor 1000 was developed to assess the employee reaction. The critical safety requirement employee would continue to perform his/her duty if he/she passed the test. The test only takes a minute to complete and employees are allowed to take the test as much as eight (8) times in order to pass it. If the employee were not able to pass the test, the employee's supervisor will assign the

employee to a different duty or send the employee home. The implementation was clever and had a faster result. Generally, the CAT requires less time than traditional testing methods (Laird, 2003; Bloom & Trice, 1997; Overton & Harms, 1997; Forker & McDonald, 1996; Wise & Plake, 1990).

3. CHAPTER THREE: EXPERIMENTAL METHODOLOGY

In this chapter, discussion focused on the Hypothesis, Participants, Research Instrument, Designs and Procedures, and Utility for Data Analysis to conduct the research study.

3.1. Hypothesis

Null Hypothesis N0: It is hypothesized that the computer based testing simulated student driving scenario software for assessing the CDL TPT in the basic driving CDL backing up skills is as equal in comparison to the traditional method of using live operational equipment and the student driver.

3.2. Participants

The selected participant would be the CDL TPT and state monitor. The CDL TPT, in the traditional testing processes, conducts the test to qualify as a tester with the state monitor. The state monitor's job is as administrator of the TPT program for his assigned region. As identified, there limited number of the CDL state monitors and CDL TPTs. Because of the limitations of the participant pool, we found there are only fourteen participants. Thirteen of the participants are the TPTs. One of the participants is the state monitor.

Due to the uncertainty of having enough or any the participants, in the original design, the researcher thought of a back up plan is to use participants other than CDL TPT and state monitor. However, the idea was found to be inaccurate for evaluating the program without an expert in the field. The initial thought of the college level student and modeling simulation professional and others as participant who has experience to take the test with computer testing materials was not implemented.

3.3. Instruments

The Virtual CDL TPT testing program utilizes a computer based testing software application, which developed for this research purpose. The test program consists of the audio and simulated animation visual content scenarios to be processing by a personal computer (PC). The program is a Windows form base. It requires the Windows XP or Windows Vista operating system (OS) to run. The researcher will utilize the laptop PC to load the executable program and the OS for this research. The test participants will interact with the program by using keyboard inputs or mouse controls. For score keeping purposes, the test program will retain only the last person's user name and scoring data. The list of documentation and equipments listed below:

- a) Explanation of Research
- b) Laptop Personal Computer loaded with Microsoft Windows OS and Virtual CDL TPT testing application (7 to 10 minutes to complete)
- c) Pre-test questionnaires
- d) Post-test questionnaires

In addition, the test environment requires a well-lit office environment with a chair and table for operating comfort.

3.4. Designs and Procedures

3.4.1. Design of the student behavior randomized mathematical model (RMM)

The construction of the CDL TPT basic backup knowledge test consist of the three (3) of the six (6) basic control skills listed below.

Basic control skill exercises include the subset of the test:

- Straight-Line Backing
- Sight Side Parallel Park
- Conventional Parallel Park
- Offset Back—Left
- Offset Back—Right
- Alley Dock

According to the state of Florida CDL driver manual, for the purpose of the basic skill backings assessment allowed for minimum select only the three skills out of six. The justification for this allowance is because physical lay of the training facility may prohibit the administration of the entire six tests. For the three selected skills, the first skill, which is Straight-Line Backing is always selected the first test by default. The second skill is the random selection between the Sight Side Parallel Park, and the Conventional Parallel Park. The third skill is the random selection of the Offset Back – Left, Offset Back – Right, and the Alley Dock. In these random cases to select the second and third skill for the test, the random math function used to calculate random for this selection and each skill is an equal probability of selection for each case.

For each of the skills selected for the first, second and third skill of the test, there is a random selection of the selected scenarios for the TPT backing up knowledge skills. There is a need to develop the student driver behavior randomized mathematical model for the scenario below.

1. The best student driver produces a score deduction of 0. (note: 0 is no error or no mistakes has been made by the student driver)
2. The good student driver produces a score deduction of 2.

3. The satisfactory student driver produces a deduction score of 4.
4. The underperformed student driver produces a deduction score of 6.

The initial design was to use the random math function as random of the 1 out of 4

Based on the use of *Rnd* function source or pseudo-code for this formula is

$$myRandomValue = CInt((4 * Rnd()) + 1))$$

According to the MSDN *Rnd* Function, the *Rnd* function returns a value less than 1 but greater than or equal to 0. The value of *number* determines how *Rnd* generates a random number:

Table 2, Rdn generation results

If <i>number</i> is	Rnd generates
Less than zero	The same number every time, using <i>number</i> as the seed.
Greater than zero	The next random number in the sequence.
Equal to zero	The most recently generated number.
Not supplied	The next random number in the sequence.

In the case of this experiment, Virtual CDL TPT system, that we have four (4) levels of driving behavior therefore four (4) is the upper bound and one (1) is the lower bound.

myRandomValue is the return result of the random number.

Following the original design, the random generated number does not enable the behavior that may change in different groups of student drivers. To add to the system to increase the realistic behavior, the scenario selection would and should not be a random function at 1/4 of the time one of those scenarios would happen. Theoretically, the formulation of the random could be based on the bell curve of the student driver's behavior. This would state that there are group of majority of students that would have score at the top. Lesser students will score at the highest score and lowest score. Collection of the falls within the range can be achieved, however the number may not be a concrete because of the fact that different waves of student can alter the

percentage of the students who fall within the specific score range. The current design approach to find this percentage is based on observation. To provide the flexibility for the administrator to change the configuration of the system to match with the seasonal students' knowledge and abilities as they change, the observation percentage is designed to be reconfigurable.

The design in random selection is based on the 100 percent mark. To answer the question, what is the percentage of time in the scenarios that the CDL TPT tester will meet the scenarios to have the student driver be rating in four categories as the best, the good, the satisfactory or the underperformed student? Based on the three scenarios described above, the selection of range for the first scenario is for the best student driver. The second selection range is for good student drivers and the third selection range is for the satisfactory and the four range is for the underperformed student driver. Using this assumption the RMM would be configured based on the percentage of the time that a random number output is generated for each scenario based on the probability of occurrence for each. The appropriate approach for this is the probability of the random thus the sum of all or probability is one (1). To apply to the case of the three random driving behavior scenarios for this project, for example if the selected parameter is at (20, 40, 30, 10). This would mean that the random outcome at 20 percent of the time are the best student drivers, 40 percent of the time are good student drivers, 30 percent of the time are satisfactory student driver and 10 percent of the time are the underperformed student drivers. The random formula pseudo-code for this implementation with the configurable parameters for this driving behavior is listed below,

*myRandomValue = CInt((100 * Rnd()) + 1))*

randomLevel = 1; 'as default

If myRandomValue <= underBound then

```

    randomLevel = 4

ElseIf myRandomValue <= satisfactoryBound then

    randomLevel = 3

ElseIf myRandomValue <= goodBound then

    randomLevel = 2

```

In this pseudo-code, the first thing is to generate the *myRandomValue* between 1 and 100. The default to look for the *randomLevel* is 1, as for the best performing student, where the *bestBound* is at 100 for value greater than *goodBound* to 100. In selection if the *myRandomValue* is less than or equal to the *underBound* value, then the return of the *randomLevel* is 4 as for the underperform student. After the *underBound* is already tested, other than the two cases above if the *myRandomValue* is less than or equal to the *satisfactoryBound*, then the *randomLevel* is set at 3 as for the satisfactory performing student. After the *satisfactoryBound* is already tested, other than the three cases above if the *myRandomValue* is less than or equal to *goodBound*, then the *randomLevel* is set at 2 as for the good performing student.

The value of *underBound*, *satisfactoryBound*, *goodBound* and *upperBound* is calculated as:

```

underBound = number4

satisfactoryBound = underBound + number3

goodBound = underBound + satisfactoryBound + number2

bestBound = underBound + satisfactoryBound + goodBound + number1

bestBound in this case is also as 100 for 100 %

```

As identified above the *randomLevel* return from this RMM for student driving behavior is either 1, 2, 3 or 4 based on the configuration input of the system administrator typical function (*number1, number2, number3, number4*). In implementation, the presentation of each scenario will be displayed by the program, as design of this RMM for each skill in accordance with the *randomLevel* randomized function of this formula.

3.4.2. Design development of the Virtual CDL TPT test application

For this research study, the Virtual CDL TPT test application was developed. The IDE utilized is the Microsoft Visual Studio Dot Net 2003 Visual Basic. For media development, Pinnacle Video Studio version 9.0 rendered the student driving scenarios. In addition to support the media development, the Microsoft (MS) Visio 2003, Microsoft Paint and Snagit application used for setting the layout and to capture the screen to video frame. For the sound effect, the truck-engine sound clips recorded at the Mid-Florida Institute CDL training center added into the media to increase the immersion effect.

Test application programming

The test application developed in Microsoft Visual Studio Dot Net 2003 Visual Basic Integrated Development Environment (IDE) depicted below.

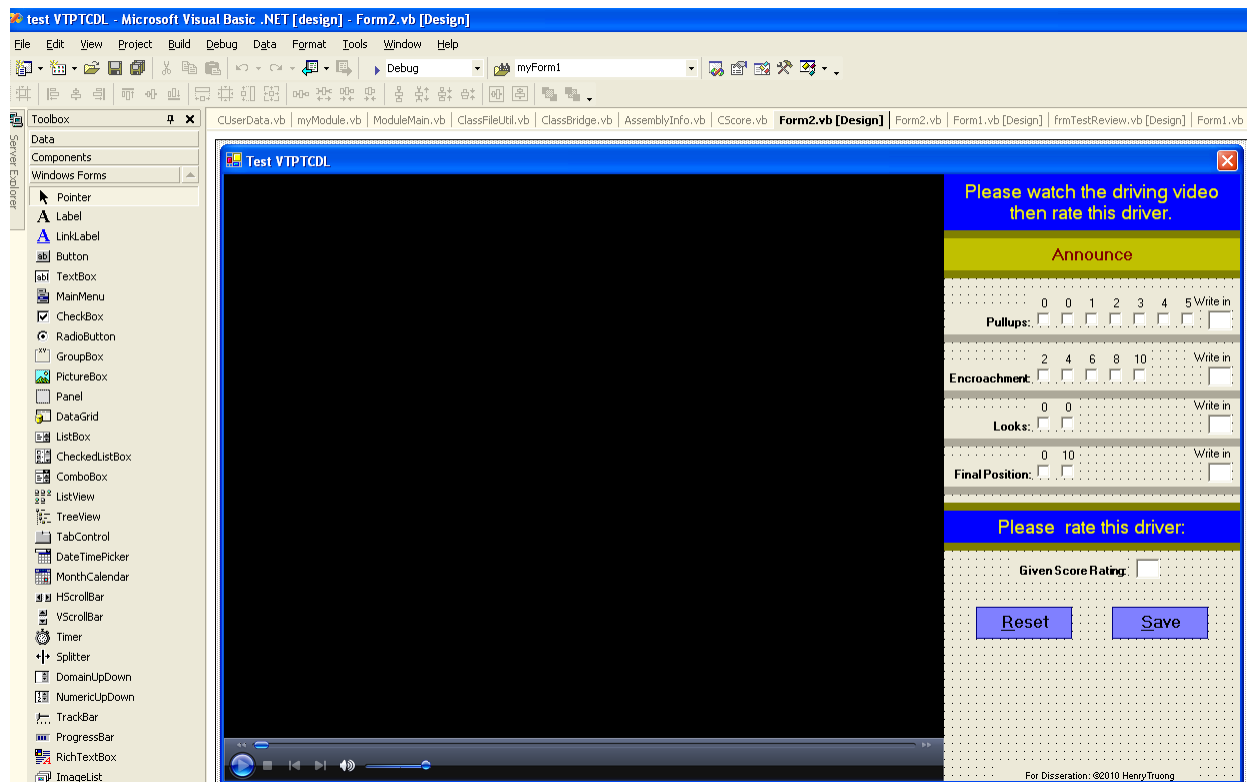


Figure 9. MS Visual Basic .NET IDE

The storyboard of the application sequences starts with a form to ask for the test taker name as shown below.



Figure 10. Input Name Required

Once the user enters their name and clicks the enter button, the program will save the name input in the Registered String Variable for record. For score keeping purpose, the name value recorded will later used by the program to write to the data file at the end of the test. The application then proceeds to the first event of the test. When the test screen starts, the test participant will visual that the test application divided the screen into two parts. On the right side of the computer screen, the application shows the student-driving scenario. On the left side of the screen, the test application displays the score panel. The test participant tasks are to view the displayed scenario and rate the maneuver of student driver by making entry on the score panel on the right. For a complete set of the test, there are three (3) display scenarios to rate. The test application will show only one scenario at a time. After each scenario is rated, and the score is careful selected and scored, the test participant can proceed with a click to the Save button. Before the end of the test, each of the Save button click, the program process the random algorithm and select a scenario with a correspondence scoreboard for the test participant to rate. The process repeated into the end after third time. After three scenarios for rating are completed the application program will display the total score given by the test taker and the comparison correct score that as preprogrammed to represent the state monitor score of the test. The test taker acknowledges this fact with the OK button. At this end state, the test taker does have an option to review the test that he/she took depicted as below:

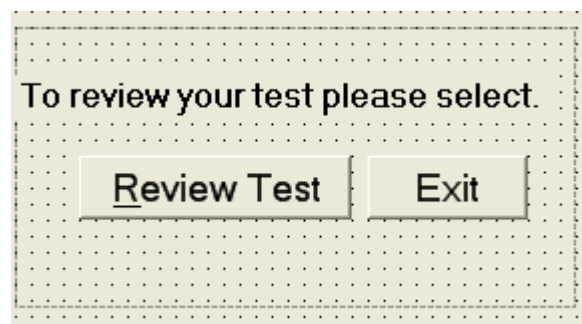


Figure 11. Option to review the test

Since the user's name and the scores during the test recorded and saved to text data file by the application, the application program's built-in capability to retrieve the information to support the review function. For the reviewing function support purpose, the set of the reviewed scenarios are the spawn matching set with the original simulated scenarios. Thus, each review scenario is tracked and is a coordination of using a matching scenario to the scenario that the tester saw during the test. These reviewed scenarios are not the same files. However, these are spawned from the original scenario with the added guide to show the errors that the student driver made during the test. Although without actual research study, these added guides were believe as designed to be helpful hints for dispute resolution with the test takers to resolve what they perceive to be scoring discrepancies.

Development of test scenarios

The video scenarios rendered with Pinnacle Video Studio depicted as below.

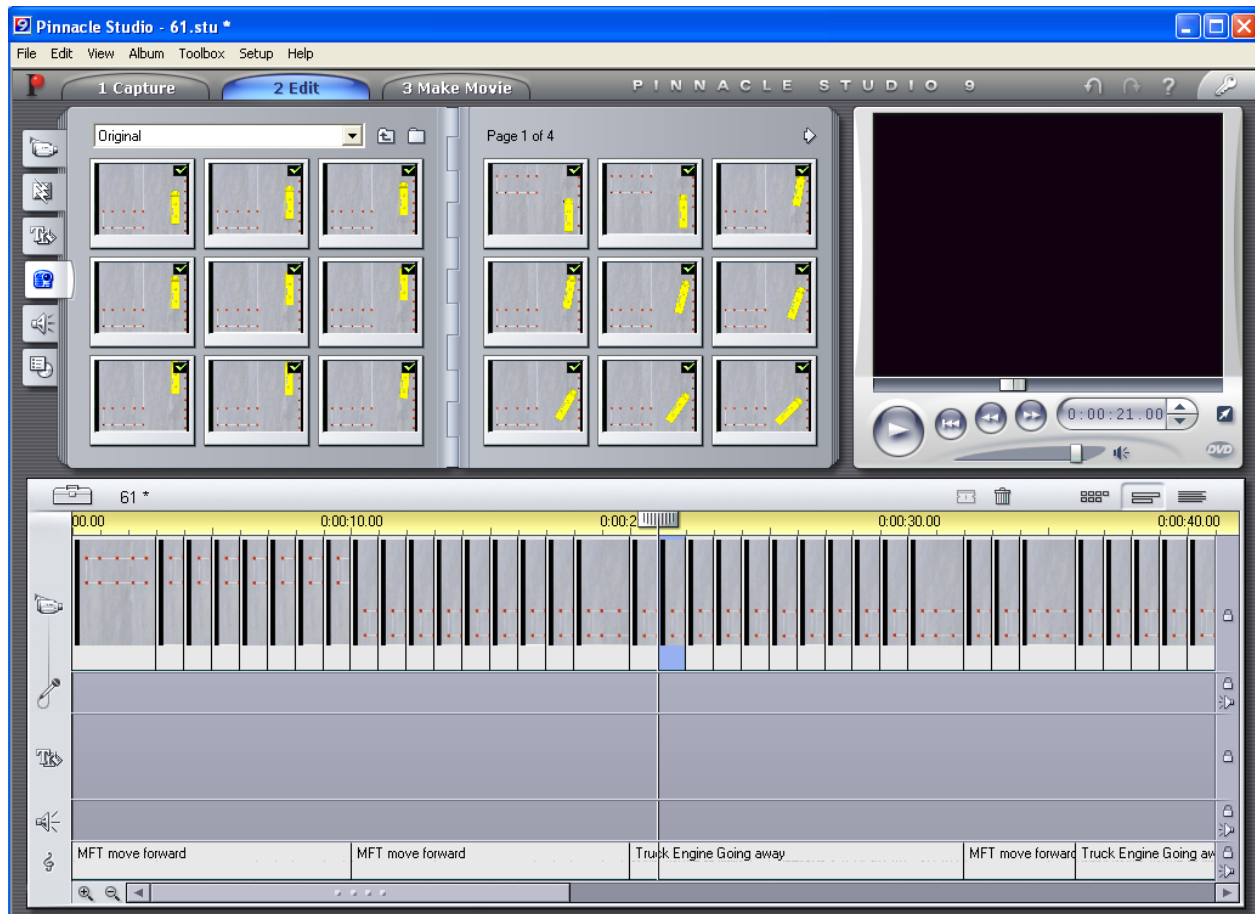


Figure 12. Pinnacle Studio Editing for Scenarios

The frame for each video picture drafted in the MS Visio depicted as below.

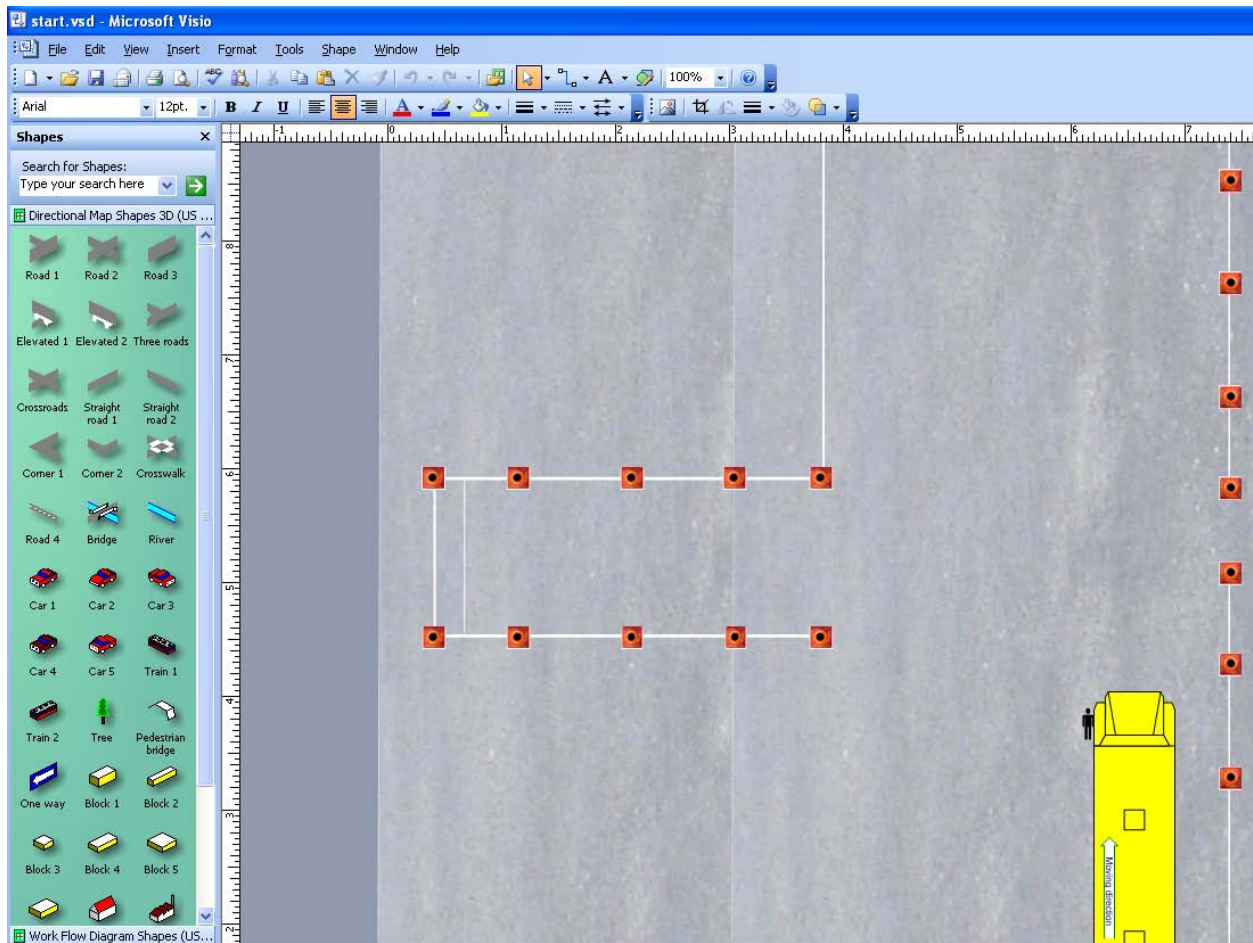


Figure 13. MS Visio for lay out

While MS Visio was used for the design of the video frame, the Snagit application, which is the Windows screen capture utility, was used to capture each of the frames. To add to the immersion with sound effects, the engine and horn sound audio files recorded during the live CDL basic backing-skill test event at the Mid-Florida Technical Institute. It is believe that these sounds blended into the simulated scenarios to boost the user immersion experience when exposed to the simulated scenarios. There are six basic backing skills as listed. For each skill, there are four variations. Thus, developed for this Virtual CDL TPT test application, the test program can select three (3) out of twenty-four (24) scenarios to display. Additionally, the spawning effort generates a set of the matching scenarios to the original twenty-four (24). As

explained, the spawn scenarios purpose is to support the review of the test. This combination brings the number of total scenarios to forty-eight (48) simulated scenario videos for the archive. Since there are only three selected scenarios will display for each test, the probability two identical tests presented is very low. The combination of the scenarios would be available for a number of variety combinations as calculated below,

Four (4) possible Straight backings * (2 * 4 possible Parallel backings) * (12 remain scenarios to be randomize) = 348 possible combinations for the three (3) required student driving scenarios.

Test scenarios validation

Validation is required to insure that the correct score is given to each scenario developed and to eliminate the problems as described by Sharp (1999), such as information specialists having to learn the unique skills to become the subject matter expert. This results in wasting time to develop the system and generates distrust in the management community to the ability of the information specialist. According to Sharp (1999), the integrity of the resulting application is improved because the subject matter expert is accountable. Upon request, an experienced subject matter expert (SME) with over 20 years in the industry helped in validation of the scenarios and the accompanying scores. The processes included reviewing each scenario slowly and at the same time scoring each of the scenarios. The SME's scores for each scenario was then compared to the developer score. If there was not a match, the scenario would be reviewed and changed either to score or to regenerate scenarios because of none smooth graphic displays or to slow down the frame's timing if the frame went too fast. Surprisingly, we found that the scenarios that we disagreed on associated to the Alley Docking Skill. This was because of one of the events in the scenario being when the student driver drove the vehicle out of bound. The

deducted score was not effective in this event. The calculated score program in the software changed to match this finding. Another issue was because of the smoothness transition of the vehicle causing the SME not to be able to keep up with the errors that the student driver presented made. Based on the SME suggestion, the selected effected scenarios were rendered again and corrected.

3.4.3. Research procedures

The design of this research is an open trial of test taking with the combination of pre and posttest evaluation. The research principle and participants expected having knowledge of the current traditional testing and the proposed CDL TPT testing system. The researcher requested for participant with CDL training centers within the central Florida. The majority of the participants requested through the state monitor

Upon permission being granted or as agreed to by the CDL TPT, experiments conducted at the training site in the facility at the participants' convenience. Prior to the event, a systematic check performed to insure that the testing system has met all system initialization criteria and is ready for testing. Upon the commencement of the event, the principle investigator showed the participant the Explanation of Research. The participants were given as much time as they required to read, and ask questions. The next step, the researcher requested the participant to response to the Pre-Test Questionnaires. After that, CDL TPT Test Application on the PC laptop introduced to the participant. Once the software initialized, the test participant just typed in the name and clicked on the enter button to begin the assessment. After the assessment, the participants had the opportunity option to review the test score with the system. In this study, all the participants interested to review to find out how they performed. This helped the participants to understand and found out how they did during the test comparing to the way the system pre

scoring in the program. Finally, after completing the computer assessment, the participants were instructed to fill out the responses to the Post-Test Questionnaires.

At the end of each participant experimentation session, the principle investigator collected the pre and post questionnaire forms and wrote down the rating score of the participant and the system result from the computer assessment on the forms. The entire procedure took less than ten (10) minutes to complete. The participants were offered \$20 for their involvement, however, most declined the monetary award.

3.5. Utility for Data Analysis

For trend analysis, the tool to uses for the study of this project is Microsoft Excel. The study design used the Liker Scale Index for questionnaires. The number attached to the answer ranging from one (1) to five (5) where rating one (1) is Strongly Disagree and rating five (5) is for Strongly Agree. The data collected to display in charting for demonstration the expert opinions based on the question solicitation. To support the testing of the hypothesis, the important data analysis helped the researcher to accept or reject the idea of using the computer-based simulation for testing to support the testing of the hypothesis.

For the statistical analysis, the tool uses for this study is the Minitab version 15. This utility uses to compare the difference between the time it take to conduct the test using traditional and the virtual test. Additionally, Minitab is also utilized to compare the test scores between the two test types.

4. CHAPTER FOUR: RESULTS

This chapter will present the data collected during the research. The data collected are two groups, from the Pre-Test and Post-Test Questionnaires and the Virtual CDL TPT testing scores as listed below. The testing of the hypothesis for this research directly relates to the Virtual CDL TPT testing scores. The answers to the pre-test and post-test questionnaires are to show the relevance and credentials of the participants. Additionally, the answers are also used to support the decision maker to understand the users' references at the time the study was conducted. Other information such as the time comparison to show the system that takes the least time. Thus, it would further support the decision making.

4.1. Data from the Pre-Test and Post Test Questionnaires

To insure the participants are relevant and have credibility in their experience to represent the CDL industry study in this research, the questions included in the pre and post test questionnaires have asked the participant's occupation and years of CDL experience. The participant's years of experience with the CDL are as shown in the Figure 14.

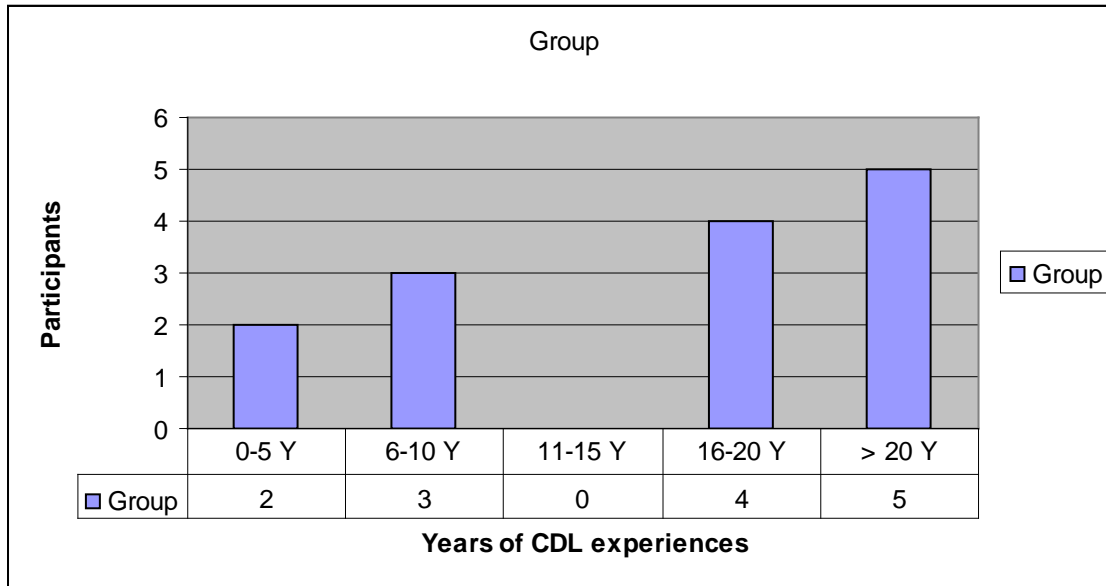


Figure 14. Participants Years of Experiences

As indicated on Figure 14, the relationship to the CDL industry experience, there are two participants that have 0 to 5 years, three participants that have 6 to 10 years, four participants that have 16 to 20 years and five participants that have more than 20 years of experience. Within the participants, there are 13 TPTs and 1 (one) state monitor.

Responses to the fourth question asked in the Pre-Test Questionnaires, “Co-scoring the basic backing skill in the traditional method is convenience “. The responses listed as below in Table 3:

Table 3, Traditional Co-scoring as Convenience

Traditional Co-scoring as Convenience			
Participant	Pre-Test	Participant	Pre-Test
1	Strongly agree	8	Strongly agree
2	Agree	9	Strongly agree
3	Agree	10	Neither
4	Agree	11	Strongly agree
5	Agree	12	Agree
6	Agree	13	Agree
7	Strongly agree	14	Neither

Grouping the above number of responses in the Strong Agree, Agree, Neither, Disagree and Strongly Disagree categories from the Pre-Test and Post-Test data on the Likert-Scale sum up as follows and is depicted in the Figure 15.

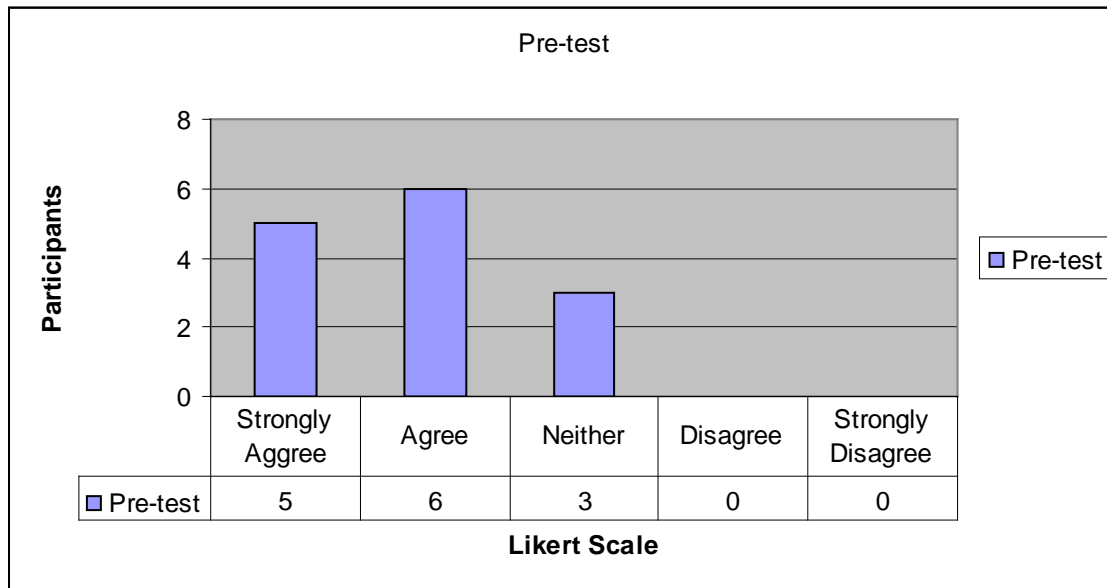


Figure 15. Traditional Co-scoring as Convenience Chart

As indicated on the chart, three (3) participants neither agree nor disagree. While six (6) participants agree, and five (5) participants strongly agree that the current and traditional co-scoring method is convenient. This result in eleven out of fourteen or 79% (seventy-nine percent) of the total participants agreed that the Traditional Co-scoring method is convenient.

Responses to the second question asked in the Pre-Test Questionnaires, “Co-scoring the basic backing skill in the computer method is very convenience.” The responses depicted as below in Table 4:

Table 4, Virtual Co-scoring as Convenience

Virtual Co-scoring as Convenience			
Participant	Post-Test	Participant	Post-Test
1	Agree	8	Neither
2	Strong Agree	9	Strong Agree
3	Agree	10	Agree
4	Agree	11	Strong Agree
5	Agree	12	Strong Agree
6	Agree	13	Neither
7	Agree	14	Agree

Grouping the above number of responses in the Strong Agree, Agree, Neither, Disagree and Strongly Disagree categories from the Pre-Test and Post-Test data on the Likert-Scale sum up as follows and is depicted in Figure 16.

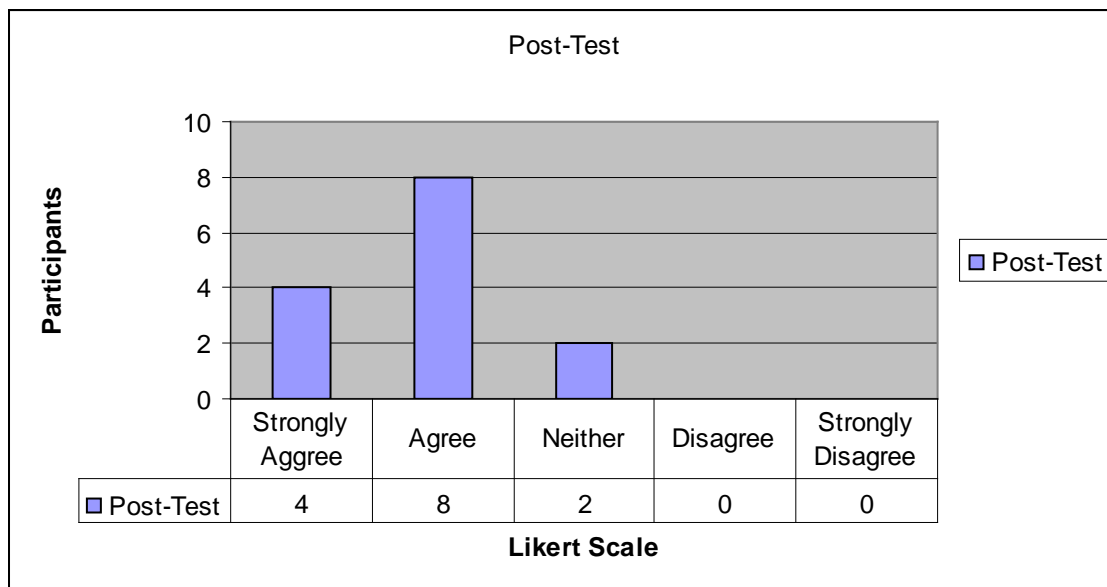


Figure 16. Virtual Co-scoring as Convenience Chart

As indicated on the chart, there are two (2) participants that neither agree nor disagree, eight (8) participants who agree and four (4) participants who strongly agree that the current and virtual co-scoring is convenient after the experiment. This result is twelve out of fourteen or 85%

(eighty-five percent) of the total participants agreed that the traditional co-scoring method is convenient.

Responses to the fifth question asked in the Pre-Test Questionnaires, “Co-scoring the basic backing skill in the traditional method is a fair assessment of the skill knowledge. I think, I always get the same score from different monitors“. The responses listed as below in Table 5:

Table 5, Traditional co-scoring is fair

Traditional co-scoring is fair			
Participant	Pre-Test	Participant	Pre-Test
1	Strongly Agree	8	Agree
2	Agree	9	Strongly Agree
3	Neither	10	Neither
4	Agree	11	Strongly Agree
5	Strongly Agree	12	Agree
6	Agree	13	Neither
7	Agree	14	Agree

With the above information, grouping the above number of responses in the Strong Agree, Agree, Neither, Disagree and Strongly Disagree categories from the Pre-Test and Post-Test data on the Likert-Scale sum up as follows and is depicted in Figure 17.

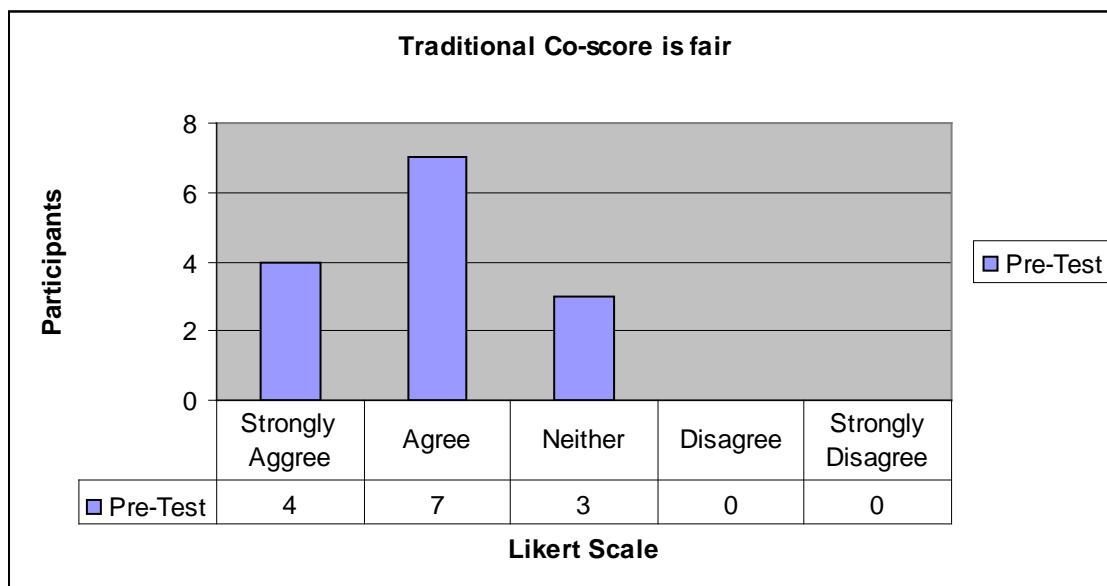


Figure 17. Traditional co-scoring is fair chart

As indicated on the chart, there are three (3) participants who neither agree nor disagree, seven (7) participants who agree and four (4) participants who strongly agree that the traditional method is a fair assessment of the skill knowledge. Therefore, in this population of study, eleven out of fourteen or 79% (seventy-nine percent) of the participants agreed the traditional test is fair.

Responses to the third question asked in the Post-Test Questionnaires, “Co-scoring the basic backing skill in the computer method provides a fair assessment of the skill knowledge from bias of the monitors. The score comparison is predetermined based on scenarios”. The responses listed as below in Table 6:

Table 6, Virtual co-scoring is fair

Virtual co-scoring is fair			
Participant	Post-Test	Participant	Post-Test
1	Agree	8	Disagree
2	Strongly Agree	9	Strongly Agree
3	Agree	10	Agree
4	Agree	11	Strongly Agree
5	Agree	12	Strongly Agree
6	Agree	13	Neither
7	Agree	14	Agree

With the above information, Grouping the above number of responses in the Strong Agree, Agree, Neither, Disagree and Strongly Disagree categories from the Pre-Test and Post-test data

on the Likert-Scale sum up as follows and is depicted in Figure 18.

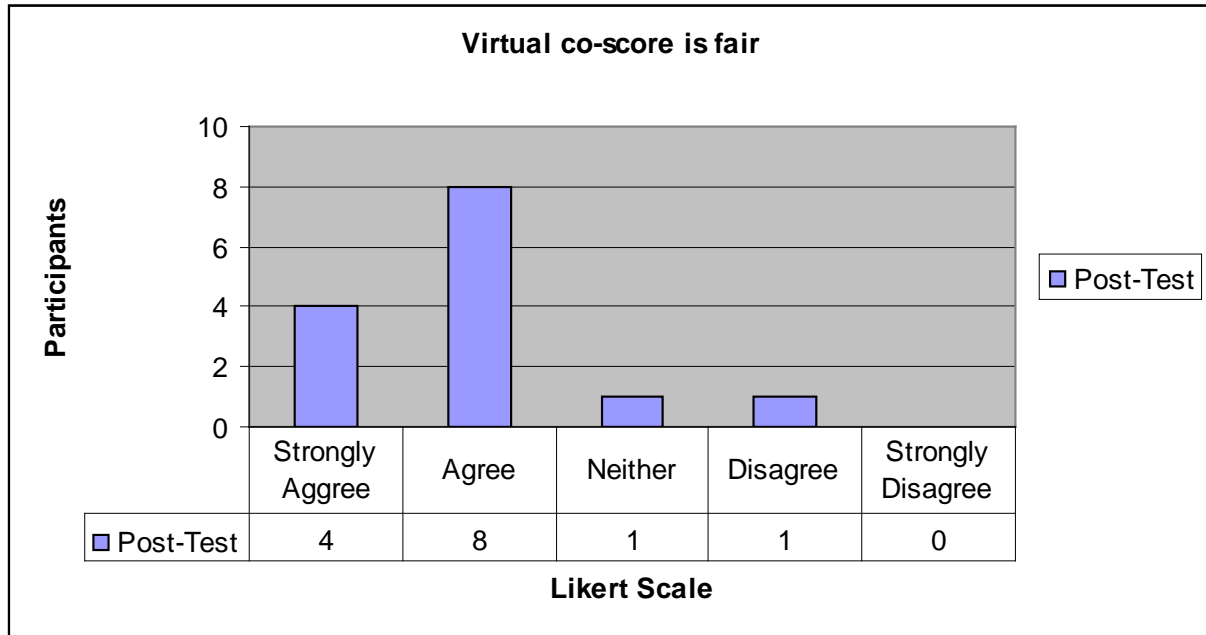


Figure 18. Virtual co-scoring is fair chart

The interpretation of the chart in Figure 18 is that the majority of participants after exposed to the Virtual CDL TPT test, twelve out of fourteen or 86% (eighty-six percent), believe that Virtual CDL TPT co-scoring is also fair.

Responses to the sixth question asked in the Pre-Test Questionnaires and the same question asked in the question number four in the Post-Test Questionnaires, “CDL TPT co-scoring basic backing can be administered by using a computer testing program”. The responses listed as below in Table 7:

Table 7, Substitute Traditional Test with Virtual CDL Test

Participant	Pre-Test	Post-Test
1	Neither	Agree
2	Agree	Strongly Agree
3	Agree	Agree
4	Agree	Agree
5	Strongly Disagree	Neither
6	Agree	Agree
7	Strongly Disagree	Neither
8	Neither	Agree
9	Strongly Agree	Strongly Agree
10	Neither	Neither
11	Neither	Agree
12	Neither	Strongly Agree
13	Agree	Agree
14	Agree	Agree

With the above information, Grouping the above number of responses in the Strong Agree, Agree, Neither, Disagree and Strongly Disagree categories from the Pre-Test and Post-Test data on the Likert-Scale sum up as follows and is depicted in Figure 19.

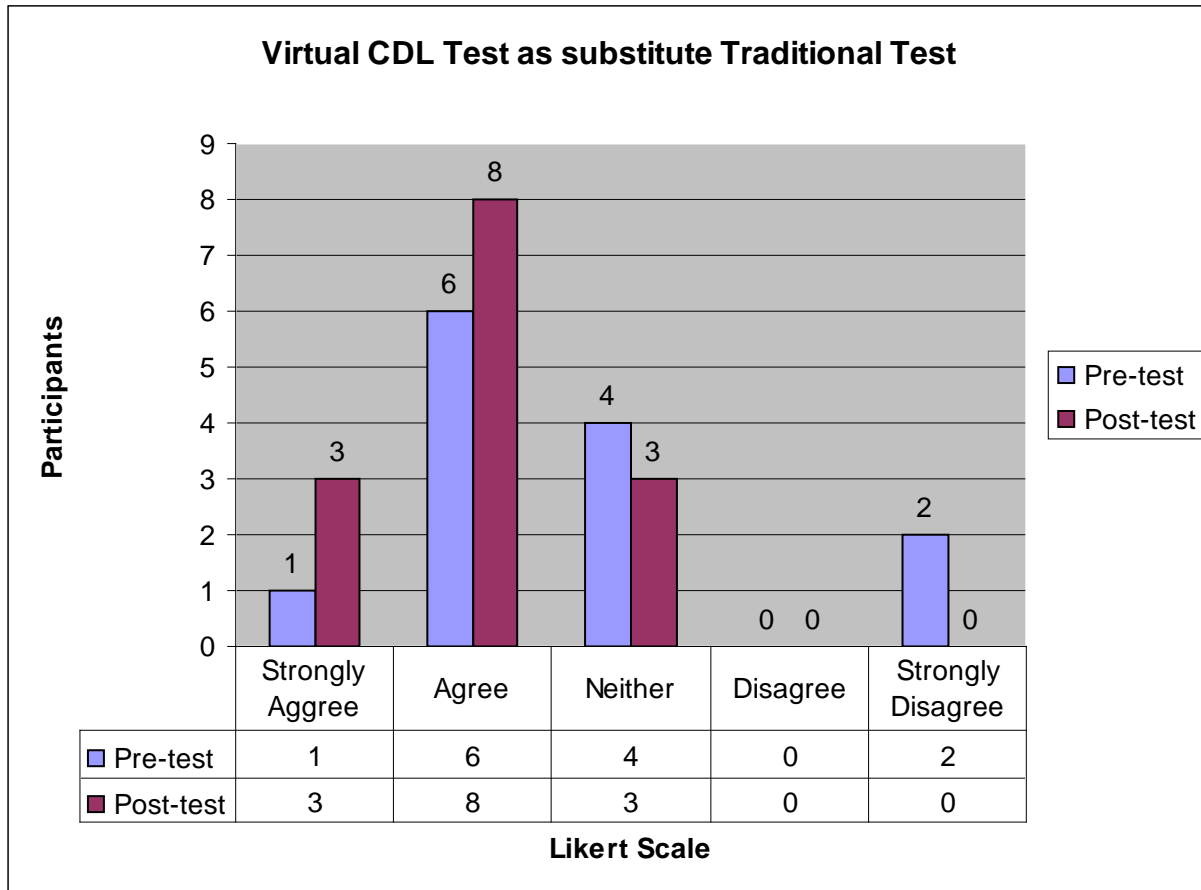


Figure 19. Virtual CDL Test as substitute for Traditional Test Chart

The interpretation of the above chart is that the majority of participants before being exposed to the Virtual CDL TPT test, seven out of fourteen or 50% (fifty percent), believed that the Virtual CDL TPT co-scoring would be able to substitute for the traditional test. Post exposure, the number of believers increased slightly, eleven out of fourteen or 79% (seventy-nine percent) agreed that the Virtual CDL Test could be substituted for the Traditional Test.

Responses to the seventh question asked in the Pre-Test Questionnaires and the same question asked in the question number fifth in the Post-Test Questionnaires, “If there is a choice between taking the test via traditional method and computer test, I would prefer to take the test via the computer.” The responses listed as below in Table 8:

Table 8, Favor of Virtual Test versus Traditional Test

Participant	Pre-Test	Post-Test
1	Neither	Neither
2	Neither	Strongly Agree
3	Neither	Neither
4	Neither	Neither
5	Disagree	Disagree
6	Neither	Neither
7	Strongly Disagree	Strongly Agree
8	Neither	Neither
9	Strongly Agree	Strongly Agree
10	Disagree	Disagree
11	Neither	Agree
12	Agree	Strongly Agree
13	Agree	Agree
14	Agree	Agree

Grouping the above number of responses in the Strong Agree, Agree, Neither, Disagree and Strongly Disagree categories from the Pre-Test and Post-Test data on the Likert-Scale responses sum up as follows and is depicted Figure 20.

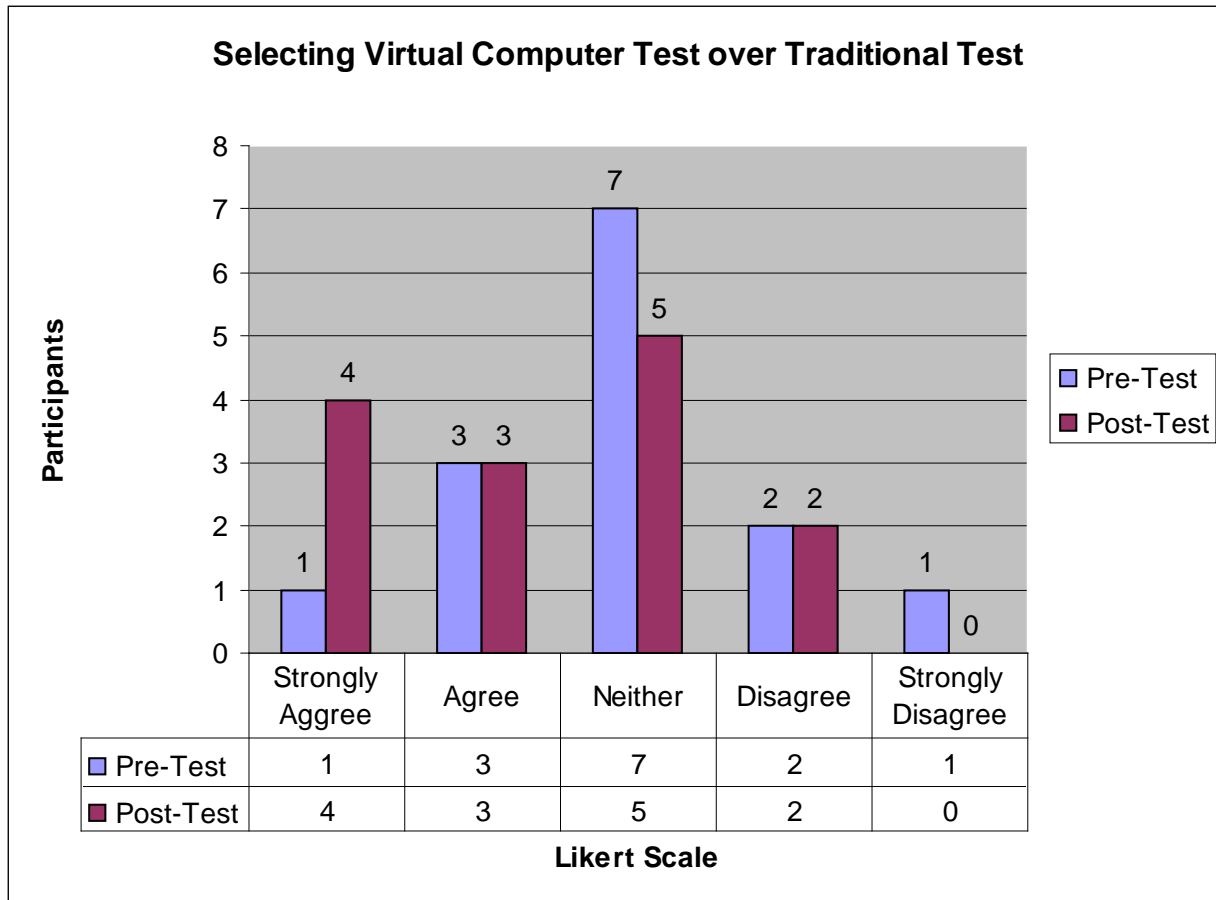


Figure 20. Selecting Virtual Computer Test over Traditional Test Chart

The interpretation of the chart in Figure 20 is that the majority of participants before being exposed to the Virtual CDL TPT test, four out of fourteen or 29% (twenty nine percent), agreed to prefer to take the Virtual CDL TPT co-scoring over the traditional test. Post exposure, the number of the participants who agreed is higher; seven (7) out of fourteen (14) a complete 50% (fifty percent) participants believed that the Virtual CDL test can be substituted for the traditional test.

Question number seven (7) in the Post-Test Questionnaires intended to collect the expert opinions about the Virtual CDL TPT test system that the participants just had the experience with to look for improvements that could be made. The question asked, “What would you

suggest to improve the computer program for the CDL TPT Virtual Testing Co-Scoring?” Based on the question the participants’ responses listed as below in Table 9:

Table 9, Response to the Post-Test question number 7th

Participant	Response
1	Improve the vehicle graphic and density of the video frame
2	Score Panel need correction because Straight backing only allow for 1 look
3	Vehicle Movement must be more fluid and less jumpy
4	Smoother graphics and have option to control the student driver as in the real test
5	Slowing down and able to Pause, correction such as cross boundary is not count as encroachment
6	Adding ability to get familiar with score sheet before the virtual test started
7	Making the method harder
8	Glitch or not too smooth in some graphic need improvement
9	Excellent, great idea, would like to improve the area when the slides jumps, other than that Love it.
10	Very good, would use this system
11	Good
12	I think it is great the way it is
13	Adding additional time to the scenarios allow the tester to look over the score sheet
14	Give tester more time to get familiar with the score sheet

Between the waiting times for accessing to participants, some but not all the participants’ response comments corrected in the software by the developer. For example, the number two (2) participant recommended that the Straight Backing Skill only allows the student driver to go out and look once. The developer corrected the software to remove one look. Before the correction was made, there is not an incorrect scoring that needed score’s adjustment. The correction suggested by participant number five (5) was corrected in the software because of the cross of boundary’s is not counted as the encroachment. The score for the participant was adjusted to reflect the correction that the test taker encountered.

In the interest of time comparison, question number three in the pre-test questionnaires asks, “If you are experienced with the CDL program, how long do you think it will take to complete the co-scoring of the Basic backing skills?” In order to compare the amount of time it takes to complete the same task via using the Virtual CDL TPT test system. The time for the test was recorded for each participant in the post-test questionnaires via question number one, which

asks, “How long did it take you to complete the co-scoring test of the basic backing skill using the computer test?” Responses to the above two questions data results listed as below in Table 10:

Table 10, Time Complete Test Traditional Versus Virtual CDL TPT Test

Time Complete Test			
Participant	Traditional	Virtual	Adjusted
1	17	4	7
2	20	6	9
3	15	4	7
4	10	4	7
5	25	4	7
6	15	4	7
7	22	5	8
8	20	6	9
9	15	6	9
10	15	3	6
11	20	3	6
12	45	4	7
13	15	6	9
14	20	3	6

Mean	20	4	7
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The above data in the chart is presented as Figure 21:

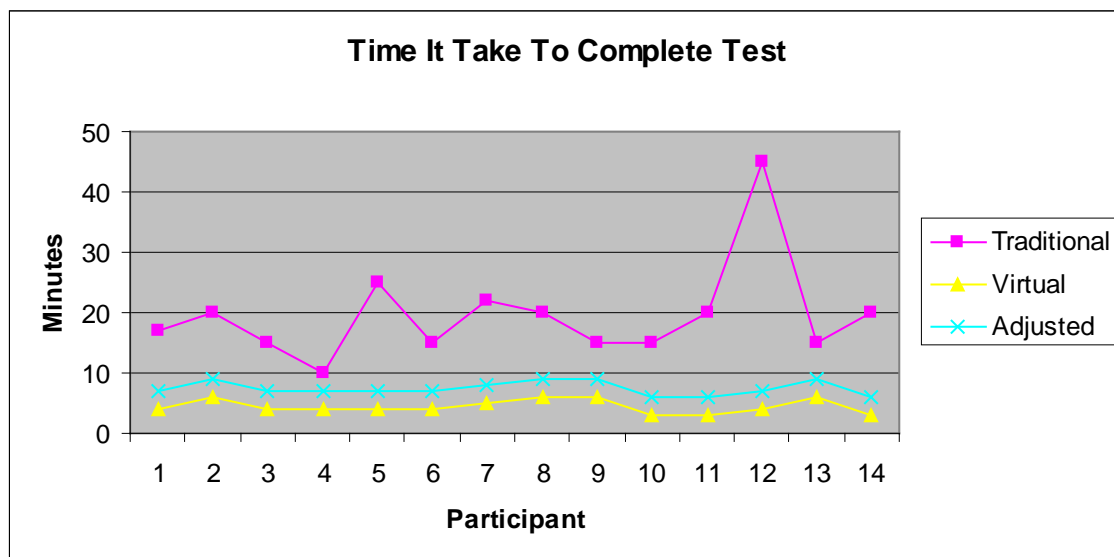


Figure 21. Time Complete Test Traditional versus Virtual CDL TPT Test chart

The adjusted score is about three (3) added into the virtual CDL TPT test per the advisement of the State Monitor. This is because of the fact that before each event even before the student driver is getting on the bus, the TPT will read a phrase and ask the student if he/she has any questions before proceeding to the test. The process will take about a minute each.

The time entries data input into Minitab for Paired T-Test analysis presented as below in Table 11:

Table 11, Minitab Time Data Input

C1	C2	C3
17	4	7
20	6	9
15	4	7
10	4	7
25	4	7
15	4	7
22	5	8
20	6	9
15	6	9
15	3	6
20	3	6
45	4	7
15	6	9
20	3	6

The results of the data analysis are listed below in Table 12, Figure 22 and Figure 23:

Table 12, Paired T-Test for time comparison

Paired T-Test and CI: C3, C1

Paired T for C3 - C1

	N	Mean	StDev	SE Mean
C3	14	7.43	1.16	0.31
C1	14	19.57	8.25	2.21
Difference	14	-12.14	8.43	2.25

95% upper bound for mean difference: -8.15

T-Test of mean difference = 0 (vs < 0): T-Value = -5.39 P-Value = 0.000

C3 stands for the adjusted times and C1 stands for the traditional testing times and these are the two values that are compared.

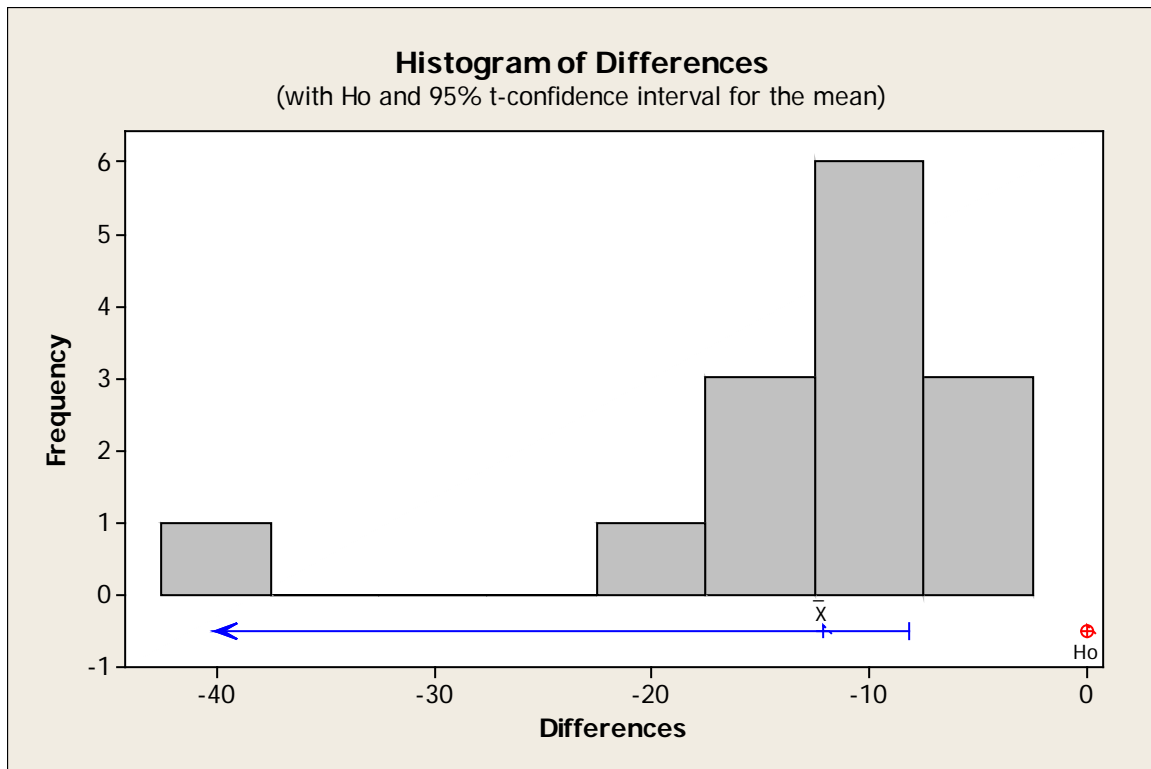


Figure 22. Histogram of Differences in Time

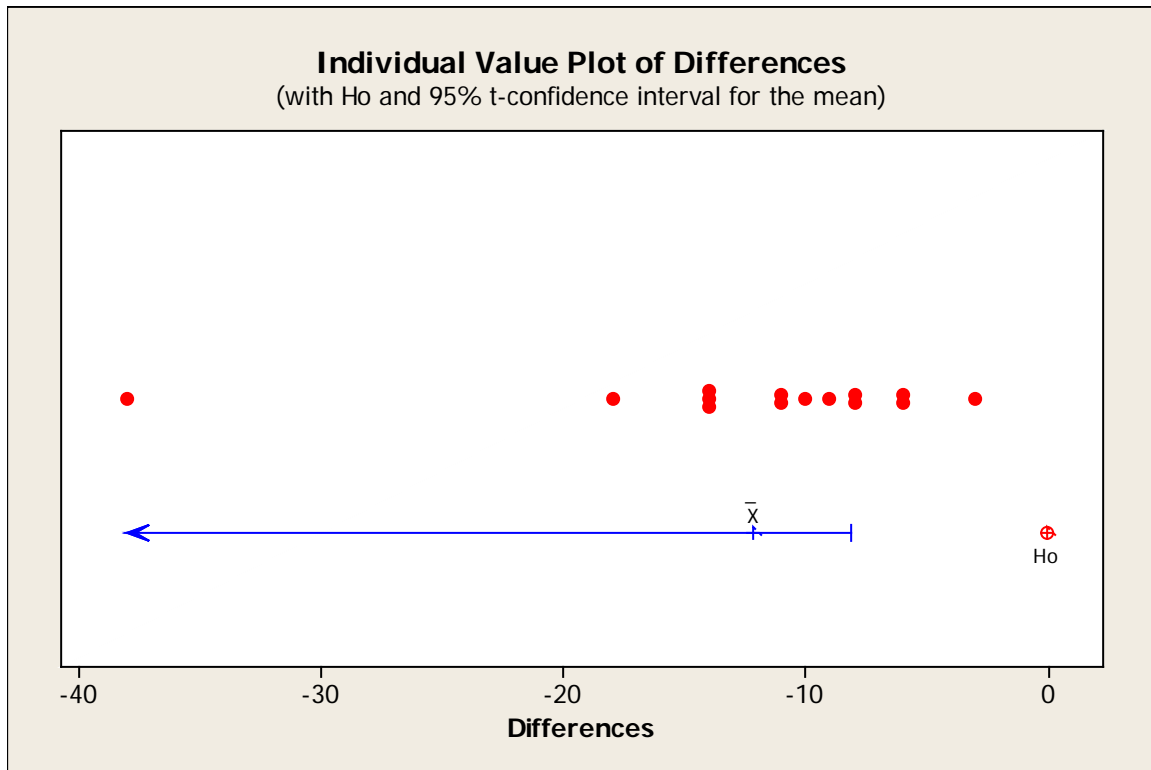


Figure 23. Individual Value Plot of Differences in time

As described in the data analysis, a 95% confidence interval was selected for the mean. Thus in the event that the null hypothesis to exanimate the time is stated as, “The time it takes to administrate the traditional CDL TPT for the basic skill backing is the same time as the virtual system.” The above data from Table 12 shows a 95% upper bound for mean difference is -8.15. This suggests that there is a difference and because there is a negative number for the upper bound value, this means the adjusted virtual system time is less than the traditional time. In the case of hypothesis testing, the test statistic is -5.39, with p-value of 0.000. Since the p-value is less than commonly chosen a-levels of .05, there is evidence for a difference in scoring between the two testing times. We could reject the null hypothesis. Because of the negative number difference, the left-tail alternative hypothesis is accepted. Thus, there is enough significant evidence that the virtual CDL TPT Test would take less time than the traditional test.

4.2. Virtual CDL TPT Testing Scores

The opening notes of this chapter related this section as an important part of the hypothesis testing. Per the data collection procedures as described in the methodology presented earlier, the participants took the test via using the newly developed Virtual CDL TPT Test application. The scores recorded as below in Table 13 and Figure 24.

Table 13, Experiment Test Scores

Participant	Participant Graded	System Graded	Percentage	Traditional Test	Virtual Test
1	12	12	100.00%	Passed	Passed
2	16	16	100.00%	Passed	Passed
3	7	8	87.50%	Passed	Passed
4	8	9	88.89%	Passed	Passed
5	10	10	100.00%	Passed	Passed
6	7	9	77.78%	Passed	Passed
7	17	17	100.00%	Passed	Passed
8	10	11	90.91%	Passed	Passed
9	15	16	93.75%	Passed	Passed
10	11	13	84.62%	Passed	Passed
11	8	8	100.00%	Passed	Passed
12	9	9	100.00%	Passed	Passed
13	14	16	87.50%	Passed	Passed
14	12	13	92.31%	Passed	Passed
N=14	11.14	11.93	93.41%		

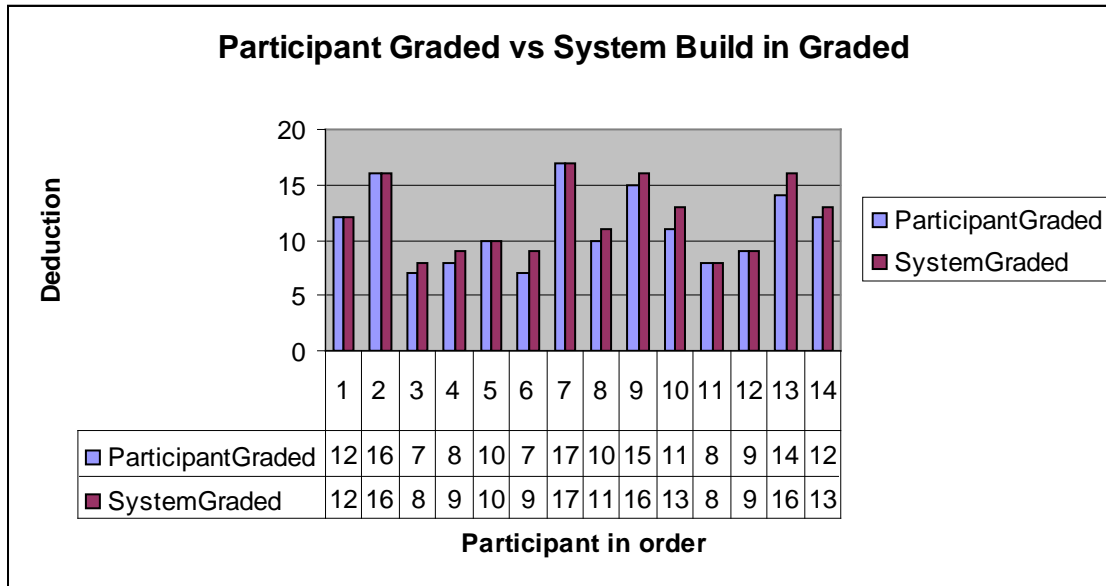


Figure 24. Participant Graded versus System Build in Graded chart

It assumed that the participants in this study already passed the traditional test and therefore would pass the virtual test. This is because of the fact that the participants are qualifying TPT and currently working as a professional on duties at the CDL training center during the experiment. This is to assume that the participant passed the traditional test at one hundred percent. However, the exact passing score that they got from the traditional test is unknown. The test results show some differences between the system pre-scores versus the participants' scores during each of the experimental runs. However, based on the interpretation of the CDL manual the difference of plus or minus two (+/-2) in this module would be considered a passing grade.

Table 14, Two Sample t-test for Tester Scoring versus State Monitor Pre-scoring Analysis
Two-Sample T-Test and CI: Tester, Monitor

Two-sample T for Tester vs Monitor

	N	Mean	StDev	SE Mean
Tester	14	11.14	3.32	0.89
Monitor	14	11.93	3.27	0.87

Difference = μ (Tester) - μ (Monitor)

Estimate for difference: -0.79

95% CI for difference: (-3.35, 1.78)

T-Test of difference = 0 (vs not =): T-Value = -0.63 P-Value = 0.534 DF = 25

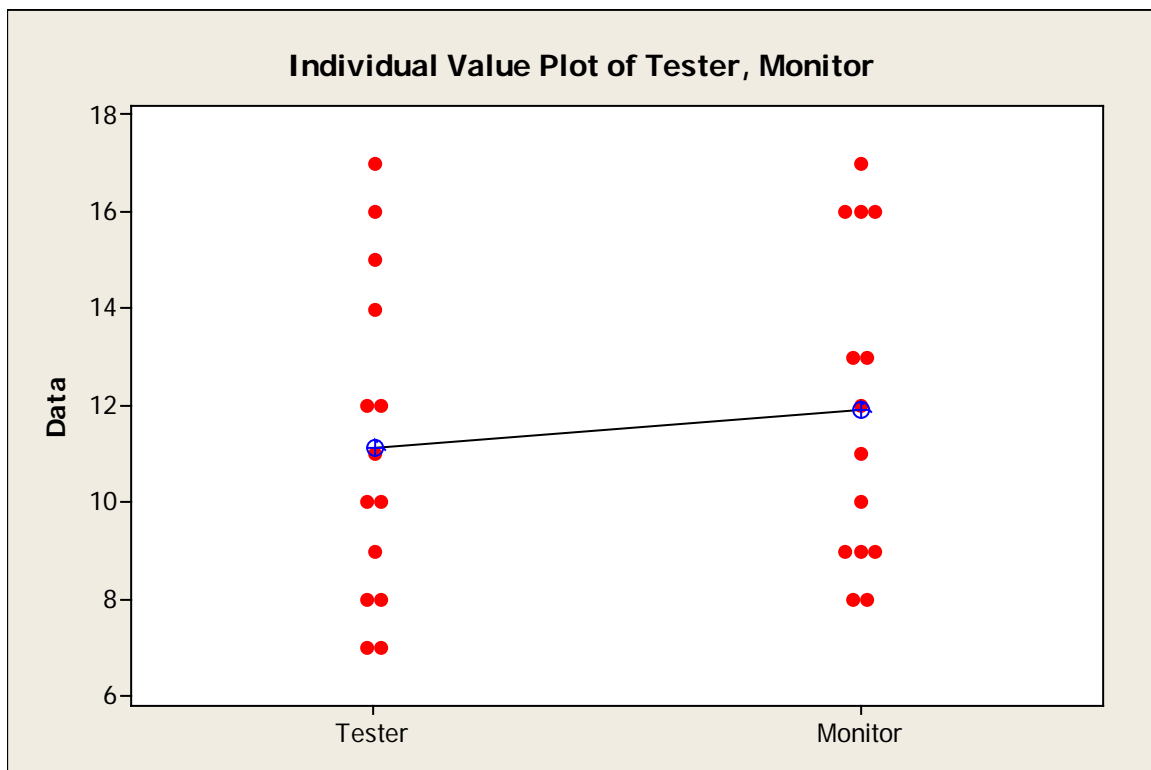


Figure 25. Individual Value Plot of Tester, Monitor

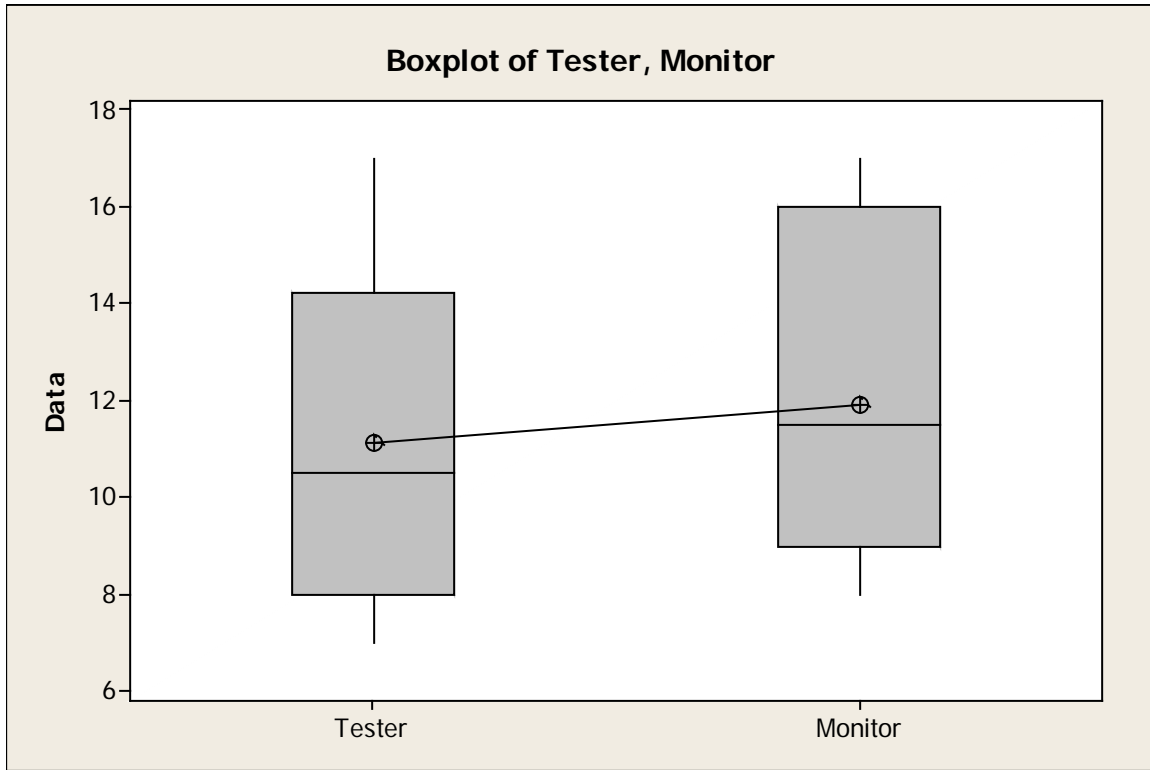


Figure 26. Boxplot of Tester, Monitor Chart

The reason to select the two samples t-test because the two populations are independent; in other words, the observation from the testers does not have any bearing on the observations from the monitors. In this case, the monitor testing score is pre-defined. Based on the data presented, we examined the significant differences of the two population means. For this case, a 95% confidence interval is (-3.35, 1.78) which includes zero suggests that there is no difference. Next is the hypothesis test result. The test statistic is -0.63, with p-value of 0.534, and 25 degrees of freedom. Since the p-value is greater than commonly chosen α -levels of .05, there is no evidence for a difference in scoring between the two independent populations. We could not reject the null hypothesis. Details above in Table 14, Figure 25 and Figure 26.

In order to establish that this Virtual CDL TPT simulation test does distinguish experts from none expert, additional data and analysis done using the Microsoft Excel program (see

Table 15) to simulate none experts and thus narrow down the gap between the experts and none experts.

Table 15, Simulated none expert model table

		Probability of Missing an Error				0.2																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																		</
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In Table 15 above, the Probability of Missing Error (PME) is a variable. The Observed is the score difference for each participant based on the data collection tests. The Random Number of Errors (RNE) is calculated by the RANDBETWEEN(7, 17). Where 7 (seven) is the lowest score observed and 17 is the highest score observed. The function dBinomialDev(a, b) produces a binomial variant for a (RNE) trials with probability b (PME) of success in each trial. The run simulated 60 times for each participant. A total of as $14 \times 16 = 840$ simulated none expert testers produced using this model. A Total Number of Simulated Match (TNSM) recorded each time the PME changed as below, in Table 16 and Figure 27.

Table 16, Total Number Simulated Match over Probability Missed Errors

PME	0.005	0.01	0.02	0.05	0.1	0.2
TNSM	296	300	317	302	264	156

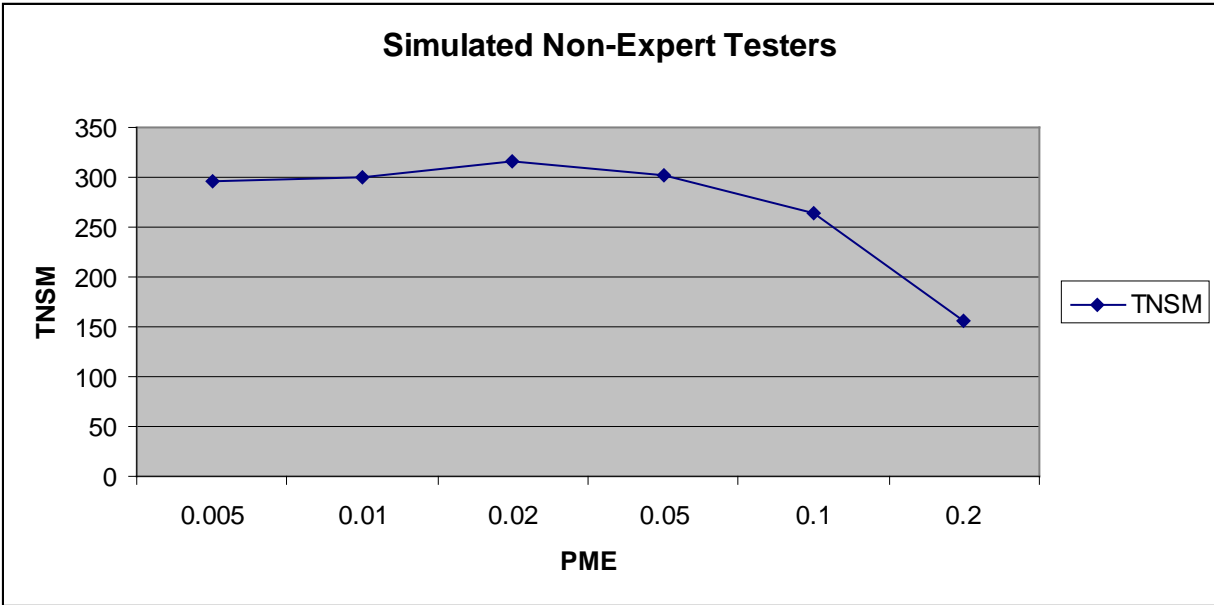


Figure 27. Simulated none expert tester chart

The simulated none expert tester indicated that the PME range from 0.005 to 0.2 on the average, $(296 + 300 + 317 + 302 + 264 + 156) / 6 = 273$ testers could guess the right answers from the 840 simulated runs. At the lower probability such as 0.005 to .005 the TNSM closed to 300s over the 840 simulated runs. As the probability getting higher to .2 or in another word 20 percent the TNSM, in this case only 156 could guess the right answer over 840 simulated runs. This gap analysis between the expert and none expert serves the purpose to differentiate between them. This gap study prevents the perceptions, that what if anyone can randomly guess the answer by using some patterns that is not truth expert. Thus for our conclusion, using the test score data collected to generate random error based on the above method to distinguish between the expert and the none expert. If the participants are likely none expert, then it is less likely the participant as none expert will guess the right answer to the test.

5. CHAPTER FIVE: CONCLUSION

5.1. Summary

The purpose of this research is to serve as the validation in the injection and integration of simulation testing using computer based technology into the current CDL TPT (Commercial Driving License Third Party Tester) qualification testing process. Literature was researched to find that there was no evidence of pre-existing research focused on the CDL TPT Skills subject; however, enough information supported the computer based testing versus paper testing in information technology and medical professions. The research methodology targeted the relevant expert participants. In addition, Virtual CDL TPT test software was developed for the sole purpose of the research. The test software was developed with the assistance of an expert and purposely-used modeling and simulation computer technology to develop this prototype concept system. During development the computer software such as MS Visio, Visual Basic, Pinnacle Studio and other software were selected to build the test system. In terms of the data collection and relevant participants, these participants were coordinated with directly from their authority with the assistance of the UCF IST and Florida Department of Highway Safety and Motor Vehicles (FLDHSMV). The data collection was done in a manner that least interrupted the participants and was accomplished at their work environment on the availability basis. Microsoft Excel with plug in PopTools and Minitab were selected for the task of performing the data analysis.

The null hypothesis was statistically tested. The conclusion was that computer-based simulated student driving scenario software is equal in comparison to the traditional method of using live operational equipment and the student driver for assessing the CDL TPT in the basic

driving CDL backing up skills. In addition, the research gathered the opinions of the participants.

In pre-testing the majority of the participants, eleven out of fourteen or 79% (seventy-nine percent) agreed that the traditional test is fair. Related to the fairness assessment, in the post-test, the majority of participants after exposed to the Virtual CDL TPT test, twelve out of fourteen or 86% (eighty-six percent) agreed that Virtual CDL TPT co-scoring is also fair.

After being exposed to the Virtual CDL TPT test, there are more participants agreed that the virtual test is fair. The number of the participants who agreed to use the Virtual CDL TPT test as a substitute are higher, eleven out of fourteen a complete 79% (seventy-nine percent) versus 50% (fifty percent) in the pre-test agreed that the Virtual CDL Test can be the substitute for the Traditional Test.

In addition, data collected on the time required to execute the CDL TPT backing skills qualification task has shown substantial time saving in the mean difference of 8.15 minutes between the traditional and the virtual system. This time saving could further improved if the implement uses multi and parallel assessments such as one state monitor to assess ten (10) or twenty (30) or more TPTs at a time.

5.2. Conclusion

From the inception of this project its conclusion, the time line is approximately two years. There are substantial amounts of information to learn and apply to the design and develop of the Virtual CDL TPT Testing System. During the tests, the system well accepted and highly praised by the participants. Particularly the state monitor participant stated, “Very good” three times. There is one participant stated that the project is good but he claimed to be old fashioned and would not want to use the computer based virtual testing system. He prefers the traditional

system. The other thirteen participants are TPTs. They are primary the CDL school instructors. Few of them thought that the scenarios build for the virtual test system would be great to expand the application of them, such as to use as teaching tool to show the students the maneuver and possible mistake that students can make. Others thought the scenarios would be good training material for instructors. This is to help them to gain more personal knowledge in the area of detecting the type of maneuver error that student may make. This is because of limitation of the facility and students ability that as the trainer he/she may not encounter on the regular training session or testing on the job.

The study result has show the promising future of the Virtual CDL TPT Test System. The use of this proposed system will not degrade the current assessment. Many other benefits such as time savings can convert to financial benefits. It is also a green technology as it reduces the use of fossil fuels during testing.. The assessment can be assesses in a safe and comfort of the office environment. From the listed benefits, as the principle investigator, I recommended for further development and using of system or concept of such the Virtual CDL TPT test system.

5.3. Lessons Learned

5.3.1. Research topic selection

From this research experience, the research topic selection was the most difficult aspect. Before this topic was selected, I wrote about six proposed topics before finally this topic was accepted. To my knowledge, the topic was completely new, thus it required me to learn and acquire the knowledge in a very short period of time. In pursuit for the CDL knowledge, I traveled to the truck training sites to observe the live event, understand what the procedures that the instructor, student and the state monitor are doing. I spent time reading the instruction

manual. During the development of the program, I sent emails or made telephone calls to ask the instructors and state monitors for some topic areas that are not clearly understood. Thus, if the research topic is part of the researcher experience, that would be an advantage.

5.3.2. Innovation

When I first began to look at the CDL program Basic Skills Backing, I was not sure what I would do about the project. At the same time, UCF IST contract project with the State of Florida FLDHSMV was videotaping at the TPT locations and was planning to have those videos in a web site as a web link. I requested to volunteer to help them and I came out to help to play the character for the video scenes. After visiting three times to the sites, I started to comprehend the procedures. That was when I thought of doing the simulated animation of the vehicle. In addition, based on my programming experience, I was able to write the test program for preparation to take the practice tests. Thus, the concept formed and I started programming a sample test system. After the first demonstration with an UCF professor, I learned the fact that he thought I just had a major breakthrough and that the project would be one of a kind.

5.3.3. Know your ability and skills

The skills and ability is very important in any start-up project. It would be difficult to complete the prototype concept without the skills and ability to create the simulation such as the Virtual CDL TPT presents in this research. Unfortunate for the doctoral research program, the financial resources available to the doctoral candidate can be limited. Having a sponsored project would be preferred. Thus, it would be lucky for someone that has the resources from the funded research project in which the researcher could have the resources for administration, or technical difficulty tasks. To add more difficult to the constrain, the committee and the adviser

also had their suggestions. The suggestions are for better ideas to a high quality and performance product. However, implement all the suggested ideas may become time consuming and resource problems. Even though, the researcher will have difficulty to refuse all added ideas. However, accept all ideas are high risk to unable to complete during the implementation. Therefore, a balancing act to accept some ideas would be challenging and time consuming. On the plus side, the researcher's ability and skills would improve because of the challenging ideas the committees came up. Therefore, continuous learning and improving the researcher ability and skills would help in this case for survival.

5.3.4. Major contribution of this study

The contribution of this study is as a prototype for one part of the three parts of the Skills assessment. The success story of this study may bring interest for study of the other modules. It may lead to the improved version of the Virtual CDL TPT to be commissioned for official testing. The involvement of the TPTs increases their acceptance about using Modeling and Simulation via the computer to assess knowledge that has long been accomplished by the traditional method of using live equipment. Some testers recognized the benefit of Modeling and Simulation in that the test scenarios would be rich in features to use as examples to show the students the concept of driving and backing that may save time and effort. The invitation of the State Monitor who is the official of the state of Florida, to participate would open the door for future endorsements of the modeling and simulation application into the State FLDHSMV program. The state monitor received a copy of the test program and intended to use it during the refresher-training course for the TPTs. The well-accepted users may lead to the attention of the administrators who are looking to solve the local, state and nationwide problem in CDL administration problems. The system like the Virtual CDL TPT testing system presented here

would be another added advantage for CDL administrator's decision of selecting the M&S as part of CDL solutions.

5.4. Suggestion for further research

There are three parts for the skill tests. This research only covered the Basic Skill Backings. The other parts that remain are the vehicle inspection and road test that need further research.

There was a suggestion from the committee that if it is possible for the replicate test to be done in a three dimensional (3D) display to bring more realism into the objects being presented helping the viewer to better accept it since it is more live like.

Other committee members suggested that the state monitor control the vehicle with a mouse during the CDL TPT assessment. This would give the state monitor better control of the subject assessed.

One of the suggestions is to use the driving database engine. The data supply for the driving engine programmed and controlled by an algorithm. The algorithm is flexible enough to accept the behavior insert to change the student behavior on the fly.

Further research to conduct would be to look at the list of suggestions for improvement by the participants as listed in Table 9, responses to the Post-Test question number seven.

APPENDIX A: EXPLANATION OF RESEARCH



EXPLANATION OF RESEARCH

Title of Project: Simulation for Commercial Driver License Third Party Testing

Principal Investigator: Henry Truong

Other Investigators:

Faculty Supervisor: Dr. Kurt Lin

You are being invited to take part in a research study. Whether you take part is up to you.

- The purpose of this study is to validate the part of the evaluation processes for Commercial Driver License (CDL) testers that uses computer and simulation based technology to replicate the traditional method of co-scoring CDL skills tests in Basic Vehicle Backing Skill. The intended benefit is a more cost-effective means of assessing tester proficiency.
- The participant is expected to fill out the Pre-questionnaire, take the Computer Based Test which is a computerized version of a standard paper and pencil test. Then, fill out the Post-questionnaire.
- The participant is expected to participate for duration about 20 minutes.

Study contact for questions about the study or to report a problem: If you have questions, concerns, or complaints please contact: Henry Truong, Graduate Student, Modeling and Simulation Program, The Institute for Simulation and Training (IST), (407) 617-9178

IRB contact about your rights in the study or to report a complaint: Research at the University of Central Florida involving human participants is carried out under the oversight of the Institutional Review Board (UCF IRB). This research has been reviewed and approved by the IRB. For information about the rights of people who take part in research, please contact: Institutional Review Board, University of Central Florida, Office of Research & Commercialization, 12201 Research Parkway, Suite 501, Orlando, FL 32826-3246 or by telephone at (407) 823-2901.

APPENDIX B: IRB APPROVAL



University of Central Florida Institutional Review Board
Office of Research & Commercialization
12201 Research Parkway, Suite 501
Orlando, Florida 32826-3246
Telephone: 407-823-2901 or 407-882-2276
www.research.ucf.edu/compliance/irb.html

Approval of Exempt Human Research

From: UCF Institutional Review Board #1
FWA00000351, IRB00001138

To: Henry Truong

Date: February 11, 2010

Dear Researcher:

On 2/10/2010, the IRB approved the following activity as human participant research that is exempt from regulation:

Type of Review: Exempt Determination
Project Title: Simulation for Commercial Driver License Third Party Testing
Investigator: Henry Truong
IRB Number: SBE-09-06249
Funding Agency:
Grant Title:
Research ID: N/A

This determination applies only to the activities described in the IRB submission and does not apply should any changes be made. If changes are made and there are questions about whether these changes affect the exempt status of the human research, please contact the IRB. When you have completed your research, please submit a Study Closure request in iRIS so that IRB records will be accurate.

In the conduct of this research, you are responsible to follow the requirements of the Investigator Manual.

On behalf of Joseph Bielitzki, DVM, UCF IRB Chair, this letter is signed by:

Signature applied by Joanne Muratori on 02/11/2010 09:07:38 AM EST

A handwritten signature in cursive script that reads "Joanne Muratori".

IRB Coordinator

APPENDIX C: PRE-TEST QUESTIONNAIRES

1. I am __State Monitor__ Third Party Tester__ College Student__M&S professional__Others

2. If you are experienced with CDL program, how many years of experience do you have?

__ Up to 5 years __6-10 years __11-15 years __16-20 years __Over 20 years

3. If you are experienced with the CDL program, how long do you think it will take to complete the co-scoring of the Basic backing skills?

4. Co-scoring the basic backing skill in the traditional method is convenient

__ Strongly Agree

__ Agree

__Neither Agree or Disagree

__Disagree

__Strongly Disagree

5. Co-scoring the basic backing skill in the traditional method is a fair assessment of the skill knowledge. I think I always get the same score from different monitors.

__ Strongly Agree

__ Agree

__Neither Agree or Disagree

__Disagree

__Strongly Disagree

6. CDL Third Party Tester co-scoring basic backing can be administered by using a computer testing program

__ Strongly Agree

__ Agree

__Neither Agree or Disagree

__Disagree

__Strongly Disagree

7. If there is a choice between taking the test via traditional method and computer test, I would prefer to take the test via the computer.

__ Strongly Agree

__ Agree

__Neither Agree or Disagree

__Disagree

__Strongly Disagree

APPENDIX D: POST-TEST QUESTIONNAIRES

1. How long did it take you to complete the co-scoring test of the basic backing skill using the computer test?

2. Co-scoring the basic backing skill in the computer method is very convenient

☐ Strongly Agree

☐ Agree

☐ Neither Agree or Disagree

☐ Disagree

☐ Strongly Disagree

3. Co-scoring the basic backing skill in the computer method provides a fair assessment of the skill knowledge from bias of the Monitors. The score comparison is predetermined based on scenarios.

☐ Strongly Agree

☐ Agree

☐ Neither Agree or Disagree

☐ Disagree

☐ Strongly Disagree

4. CDL Third Party Tester co-scoring basic backing can be administered by using a computer testing program

☐ Strongly Agree

☐ Agree

☐ Neither Agree or Disagree

☐ Disagree

☐ Strongly Disagree

5. If there is a choice between taking the test via traditional method and computer test, I would prefer to take the test via the computer.

☐ Strongly Agree

☐ Agree

☐ Neither Agree or Disagree

☐ Disagree

☐ Strongly Disagree

6. What would you suggest to improve computer program for CDL Third Party Tester Virtual Testing Co-Scoring?

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